

SOIL SURVEY

Norris Area Tennessee

Series 1939, No. 19



Issued August, 1953

How To Use THE SOIL SURVEY REPORT

FARMERS who have lived in one locality for a long time come to know about the soil differences on their own farms and on those of their immediate neighbors. What they do not know, unless a soil survey has been made, is how nearly their soils are like those at experiment stations or in other localities from which higher yields are reported. They do not know whether these higher yields are from soils like their own or so different that they could not hope to get equally high returns, even if they adopted the practices followed in these other places. The similarities and differences among soils are known only after a map of the soils has been made. Knowing what kind of soil one has and comparing it with soils on which new developments have proved successful will remove some of the risk in trying new methods and varieties.

SOILS OF A PARTICULAR FARM

To find what soils are on any farm or other land, locate the tract on the soil map, which is in the envelope inside the back cover. This is easily done by finding the section the farm is known to be in and locating its boundaries by such landmarks as roads, streams, villages, and other features.

Each kind of soil is marked with a symbol on the map; for example, all soils marked Grn are of the same kind and have the same symbol. To find the name of the soils so marked, look at the legend printed near the margin of the map and find the symbol. The color for Grn indicated in the legend will be the same as the color in which it is shown on the map. Grn stands for Greendale silt loam, undulating phase. A section of this report (see table of contents) describes Greendale silt loam, undulating phase, discusses the purposes for which it is mainly used, and tells some of the uses for which it is suited.

Suppose, for instance, you desire to know how productive Greendale silt loam, undulating phase, is. Find this soil name in the left-hand column of table 6, and note the yields of the different crops opposite it. This table also gives expectable yields for all the other soils mapped, so that the different ones may be compared.

Read in the section on Soil Types and Phases to learn what are good uses and management practices for Greendale silt loam, undulating phase. Look also in the section Soil Use and Management and find the management group (see table 5) to which this soil belongs.

SOILS OF THE COUNTY AS A WHOLE

If a general idea of the soils of the county is wanted, read the introductory part of the section on Soils. This tells where the principal kinds are found, what they are like, and how they are related to one another. Then study the soil map and notice how the different kinds of soils tend to be arranged in different localities. These patterns are likely to be associated with well-recognized differences in type of farming and land use.

A newcomer who considers purchasing a farm in the county will want to know about the climate as well as the soils; the types and sizes of farms; the principal farm products and how they are marketed; kinds of farm buildings, equipment, and machinery; availability of schools, churches, highways, railroads, telephone and electric services; and water supplies; industries; and cities, villages, and population characteristics. This information will be found in the sections on General Nature of the Area and on Agriculture.

Students and others interested in how the soils of the county were formed and how they are related to the great soil groups of the world should read the section on Morphology and Genesis of Soils.

This publication on the soil survey of the Norris area, Tennessee, is a cooperative contribution from the—

SOIL CONSERVATION SERVICE

ROBERT M. SALTER, *Chief*

CHARLES E. KELLOGG, *Chief, Soil Survey*

TENNESSEE AGRICULTURAL EXPERIMENT STATION

J. H. McLEOD, *Director*

F. S. CHANCE, *Vice Director*

and the

TENNESSEE VALLEY AUTHORITY

SOIL SURVEY OF THE NORRIS AREA, TENNESSEE ¹

By FOSTER RUDOLPH, in Charge, WALLACE ROBERTS, M. H. GALLATIN, M. E. AUSTIN, J. N. ODOM, CLIFTON JENKINS, L. E. ODOM, and M. E. SWANN, Tennessee Agricultural Experiment Station, and S. R. BACON, A. J. VESSEL, M. J. EDWARDS, and M. G. CLINE, Division of Soil Survey,^{1a} Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, United States Department of Agriculture

Area inspected by J. W. MOON, Principal Soil Scientist, Division of Soil Survey

United States Department of Agriculture in Cooperation with the Tennessee Agricultural Experiment Station and the Tennessee Valley Authority

CONTENTS

	Page		Page
General nature of the area.....	3	Soils—Continued	
Location and extent.....	3	Claiborne silt loam:	
Physiography, relief, and		Hilly phase.....	38
Drainage.....	3	Rolling phase.....	40
Climate.....	6	Steep phase.....	42
Water supply.....	8	Clarksville cherty silt loam:	
Vegetation.....	8	Hilly phase.....	43
Organization and population..	8	Rolling phase.....	45
Industries.....	9	Steep phase.....	47
Transportation and markets..	9	Clarksville loam, rolling	
Schools, churches, and home		phase.....	48
improvements.....	10	Colbert silt loam, rolling	
Agriculture.....	10	deep phase.....	49
Crops.....	10	Colbert silty clay loam,	
Potations and fertilizers.....	12	eroded rolling phase.....	50
Pastures.....	13	Cumberland silt loam.....	51
Livestock and livestock prod-		Dewey silt loam, undulating	
ucts.....	13	phase.....	52
Types of farms.....	14	Dewey silty clay loam:	
Land use.....	14	Eroded hilly phase.....	53
Farm equipment and expendi-		Eroded rolling phase.....	54
tures.....	15	Eroded steep phase.....	56
Soil survey methods and defini-		Emory silt loam, undulating	
tions.....	15	phase.....	57
Soils.....	18	Fullerton cherty loam, roll-	
Soil series and their relations..	19	ing phase.....	58
Soils of uplands.....	20	Fullerton cherty silt loam:	
Soils of colluvial lands.....	21	Hilly phase.....	60
Soils of stream terraces.....	22	Rolling phase.....	61
Soils of bottom lands.....	23	Steep phase.....	63
Soil types and phases.....	23	Fullerton loam, rolling phase..	64
Allen loam.....	24	Fullerton silt loam:	
Alluvial soils, undifferen-		Hilly phase.....	66
tiated.....	26	Rolling phase.....	68
Armuchee silt loam:		Steep phase.....	70
Hilly phase.....	27	Undulating phase.....	71
Steep phase.....	28	Greendale silt loam:	
Bolton silt loam:		Rolling phase.....	72
Hilly phase.....	29	Undulating phase.....	73
Rolling phase.....	31	Hector stony fine sandy	
Steep phase.....	32	loam, steep phase.....	75
Capshaw silt loam.....	34	Jefferson stony fine sandy	
Caylor silt loam:		loam, rolling phase.....	75
Rolling phase.....	35	Leadvale silt loam:	
Undulating phase.....	37	Rolling phase.....	77

¹ Revised by L. E. Odom, associate agronomist, Tennessee Agricultural Experiment Station.

^{1a} The Division of Soil Survey was transferred to the Soil Conservation Service on November 15, 1952.

	Page		Page
Soils—Continued		Land classification, soil use and man-	
Leadvale silt loam—Con.		agement, and estimated yields	109
Undulating phase	79	Land classification	109
Lehew fine sandy loam:		First-class soils	112
Hilly phase	80	Second-class soils	112
Steep phase	81	Third-class soils	112
Limestone rockland:		Fourth-class soils	113
Rolling	82	Fifth-class soils	113
Rough	83	Soil use and management	113
Lindsay silt loam	83	Estimated yields	130
Montevallo shaly silt loam:		Soil associations	135
Rolling phase	85	Muskingum-Jefferson-Armu-	
Steep phase	85	chee association	135
Muskingum stony fine sandy		Talbott-Caylor-stony land as-	
loam:		sociation	136
Hilly deep phase	87	Clarksville-Fullerton-Claiborne	
Steep phase	87	(hilly to steep) association	137
Ooltewah silt loam	89	Clarksville-Fullerton-Claiborne	
Philo fine sandy loam	90	(rolling to hilly) association	137
Pope fine sandy loam	91	Fullerton-Claiborne-Bolton as-	
Roane silt loam	92	sociation	138
Rolling stony land (Talbott		Stony land-Talbott-Caylor as-	
soil material)	94	sociation	138
Rough gullied land:		Lehew association	139
Montevallo soil material	95	Montevallo-Leadvale-Armu-	
Talbott soil material	96	chee association	139
Rough stony land (Fullerton		Armuchee-Sequoia association	140
soil material)	96	Dewey-Fullerton-Claiborne as-	
Sequatchie fine sandy loam	97	sociation	140
Sequoia silt loam, undulat-		Sequoia-Armuchee association	140
ing phase	99	Forests	141
Sequoia silty clay loam,		Morphology and genesis of soils	145
eroded rolling phase	100	General environment and mor-	
Smooth stony land (Talbott		phology of soils	146
soil material)	101	Classification of soil series	150
Talbott silt loam, undulating		Red Podzolic soils	153
phase	102	Yellow Podzolic soils	160
Talbott silty clay loam:		Planosols	164
Eroded hilly phase	104	Lithosols	165
Eroded rolling phase	105	Alluvial soils	169
Eroded steep phase	107	Literature cited	172
Tyler silt loam	108	Soil map and supplement	
	cover page	3

ALL of Union and parts of Campbell and Anderson Counties are in the Norris area. About half the area is in cut-over forest, and Norris Lake covers approximately 30,000 acres. Agriculture, mainly the production of subsistence crops, is the chief industry. Corn and hay are the principal crops, but wheat, oats, barley, vegetables, and fruits are also grown. Tobacco has become a leading cash crop in recent years. Livestock raising, mainly for home and local use, is important to the agriculture practiced. Industry other than agriculture is limited. A number of people are employed in a small garment factory in La Follette, in the nearby Cumberland Mountain coal mines, and in the cutting and marketing of forest products. To provide a basis for the best agricultural uses of the land this cooperative soil survey was made by the United States Department of Agriculture, the Tennessee Agricultural Experiment Station, and the Tennessee Valley Authority. Field work was completed in 1939. Unless otherwise specifically mentioned, all statements in this report, including

recommendations on fertilization and other soil management, refer to conditions or practices in the county at the time field work was completed.

GENERAL NATURE OF THE AREA

LOCATION AND EXTENT

The Norris area is in the Great Valley of East Tennessee, a region of alternate parallel ridges and valleys underlain by dolomite, shale, and limestone. The area includes all of Union and parts of Campbell and Anderson Counties. It is roughly oval in shape and is bounded on the east by Grainger and Claiborne Counties; on the north, by the Cumberland Mountains; on the west, by United States Highway No. 25W; and on the south, by Anderson and Knox Counties. Maynardville, the county seat of Union County, is 20 miles north of Knoxville; Jacksboro, the county seat of Campbell County, is 22 miles west of Maynardville; and La Follette is the principal town (fig. 1). The land area is 240,000 acres, or 375 square miles. Norris Lake covers an additional tract of about 30,000 acres (pl. 1, A).

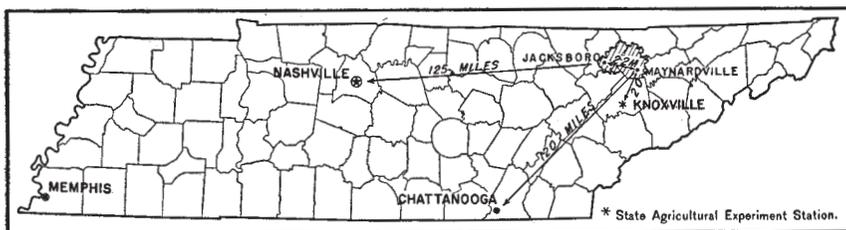


FIGURE 1.—Location of the Norris area in Tennessee.

PHYSIOGRAPHY, RELIEF, AND DRAINAGE

Physiographically, the Norris area is within the Great Valley of East Tennessee (8),² which is a belt of lowland lying between the Cumberland Mountains on the northwest and the Great Smoky Mountains on the southeast (19, 20). The Great Valley is not a river valley, but was formed by the weathering of the underlying limestone and shale that are less resistant than the rock underlying the adjoining highlands. This valley varies from place to place in both relief and elevation and contains many minor roughly parallel ridges and valleys. From its greatest elevation in the State, a point near Bristol about 2,100 feet above sea level, the valley gradually slopes southwestward to an altitude of about 600 feet in the vicinity of Chattanooga.

Sedimentary rock formations underlie the Norris area; and these are of limestone, dolomitic limestone, shale, or sandstone (19, 20, 2).³ Both the limestone and shale show wide local variations in content of carbonates, although most of the shale is noncalcareous. Severe

² Italic numbers in parentheses refer to Literature Cited, p. 172.

³ TENNESSEE VALLEY AUTHORITY. GEOLOGIC MAP OF NORRIS RESERVOIR AND SURROUNDING REGION. Water Control Planning Dept., Geol. Div., 1937.

folding and faulting have left many of the rock beds inclined at high angles or actually overturned, and there are several exposures of the same beds. This folding and faulting and the differential weathering incident to variations in the underlying rock formations have resulted in a series of relatively narrow parallel physiographic belts, which cross the area in a northeast-southwest direction parallel to the exposures of the geologic formations.

The Norris area is crossed by four minor physiographic belts—(1) the Cumberland Mountains in the extreme northwest, (2) Powell Valley in the northwest and adjacent to the Cumberland Mountain escarpment, (3) the dolomitic hills in the northwestern and central parts, and (4) the faulted ridge and valleys in the southeastern part (fig. 2).

The Cumberland Mountains terminate in a steep rocky southeast-facing escarpment that forms the northwestern rim of the Great Valley and the boundary of the Norris area. The rock underlying the mountains is massive conglomerate sandstone, which is underlain by interbedded limestone and shale on the lower slopes. The general level of the mountain crests is about 2,500 feet, but the boundary of the area is below the crests in all places.

Powell Valley is underlain chiefly by high-grade limestone of the Chickamauga group.⁴ Because these rocks weather rapidly and leave little residue, the general elevation of this valley (about 1,200 feet) is about 300 feet lower than the cherty ridges to the southeast and 1,200 feet lower than the Cumberland escarpment on the northwest. The valley is predominantly undulating to rolling, but there are some scattered hilly areas. It is crossed by many small perennial and intermittent streams, and these have formed a trellised drainage pattern. The stream courses are comparatively straight and their present flood plains narrow, but their valleys are rather wide. Stream terraces, together with colluvial deposits and local alluvium, form low fans and benches throughout the valley, and small lime sinks are common in many places.

The dolomitic hill area is in the central part and is underlain by cherty and sandy dolomite and dolomitic limestone of the Knox formation.⁵ Smooth well-rounded hills with narrow steep-sided V-shaped valleys are characteristic. The most conspicuous feature is the deeply entrenched gorge of the Powell River. This river follows a broadly meandering but generally southwesterly course through the center of the area. Small tributaries have caused steep and rugged relief by deeply dissecting an area that extends 2 or 3 miles back from the river on either side. The flood plains and terraces of the river and its tributaries are very narrow, and practically all have been flooded by the waters of the Norris Reservoir. Although the relief and topography described are characteristics of the greater part, some of the area just north of the Clinch River has a modified karst topography. Here lime sinks, very small to several acres in size, are common. The land surface is very irregular, but slopes are not so steep as in the stream-dissected part. Elevations range from about 1,000 to 1,550 feet (19).

The ridge and valley area lies southeast of the Clinch River and consists of alternate steep ridges and narrow valleys. The underlying

⁴ See footnote 3, p. 3.

⁵ See footnote 3, p. 3.

rock formations are sharply tilted, and differential weathering is largely responsible for the present ridges and valleys. In general, the smoother round-topped ridges are capped with dolomite or dolomitic limestone and the steep narrow-crested ones by sandstone and shale. The valleys are underlain by limestone, interbedded limestone and shale, or shale. The ridges have a maximum elevation of about 1,500 feet, and the valleys range from 1,050 to 1,200 feet (19).

Folding and faulting have exposed many rock formations in this area. Clinton sandstones are exposed on Big Ridge and Clinch Mountains. Juniata and Reedsdale shales are below the Clinton sandstone and are exposed on the northwest slopes of Big Ridge, Pine Ridge, and eastern Lone Mountain. The Trenton, Black River, and Stones River limestones are in Big, Hickory, Raccoon, and Flat Creek Valleys. These formations are underlain by Knox dolomite, which not only underlies all the dolomitic hill area, but also Wallens, Chestnut, Hinds, and Copper Ridges in this area. The Nolichucky shale formation is exposed in Hinds, Opossum, Beard, Texas, and Potato Valleys. Relatively thin beds of Maryville limestone, Rogersville shale, and Rutledge limestone are between the Nolichucky shale and the Rome formation. The Rome formation is the oldest one exposed in this area; it underlies Pine Ridge, Comb Ridge, Log Mountain, and eastern Lone Mountain (20, 2).⁶

There is considerable range in elevation within the Norris area. Eastern Lone Mountain has a maximum elevation of about 2,000 feet. The Clinch River, at Norris Dam, has a normal elevation of 820 feet. The elevations of the valleys range from about 1,000 to 1,300 feet. Maynardville has an elevation of 1,200 feet; Jacksboro, 1,220; La Follette, 1,060; and Luttrell, 1,060. (19).

Drainage in the area is well developed. The general slope and the flow of the rivers are toward the southwest. Only a narrow divide separates the Clinch River in the central and the Powell River in the north central part, and these rivers join about 6 miles northeast of Norris Dam. Their relatively short tributary streams are less than 5 miles long and form a trellislike pattern. In the ridge and valley area just south of the Clinch River, the drains follow the valley floors for short distances before entering the river through the numerous water gaps in the ridges. Flat Creek in the southeastern part of the area is a tributary of the Holston River. Much of the drainage in the areas underlain by limestone or dolomite is subterranean. The water flows through crevices and solution channels in the underlying rock.

CLIMATE

The climate of the Norris area is temperate and continental. The summers are long and warm and the winters are short and open. The spread between the mean winter and mean summer temperatures is 36.8° F. The lowest winter temperature recorded near Tazewell was -29° in December; but winters are normally not cold, the mean winter temperature being 36.2°. Sudden temperature changes, however, are frequent in winter. The ground is seldom covered with snow for more than a few days at a time, and the soil freezes to a depth of only

⁶ POND, W. F. GEOLOGIC MAP OF TENNESSEE. Tenn. Dept. of Ed., Div. of Geol., Ed. 4. 1933.

a few inches. The mean summer temperature is 73°, but a temperature of 106° has been recorded in July; and hot sultry days are common in summer. The average frost-free period of 173 days extends from April 25 to October 16. Killing frosts have been recorded as late as May 14 and as early as September 30, but normally crops are not injured by frost. The grazing period extends from about the first of April to the middle of November.

The average annual precipitation is 50.21 inches. The rainfall is evenly distributed through the winter, spring, and summer months and is lowest in fall when many crops are being harvested. The highest mean monthly rainfall (5.22 inches) falls in March and the lowest (2.97 inches) in October. Many times the summer rains are torrential downpours accompanied by severe thunderstorms, but for the rest of the year rains are usually moderate and steady. An average of 10.4 inches of snow falls in winter. Neither droughts nor periods of excessive rainfall are common but crop yields, especially on droughty soils, are sometimes materially reduced by periods of light rainfall.

Slight variations in temperature and rainfall are probably due to local differences in elevation, exposure, and air drainage. These variations are not great enough, however, to affect the general type of agriculture over the area as a whole.

Data on normal monthly, seasonal, and annual temperature and precipitation that may be considered fairly representative of the Norris area are given in table 1 for the United States Weather Bureau station at Tazewell in Claiborne County, Tenn.

TABLE 1.—Normal monthly, seasonal, and annual temperature and precipitation at Tazewell,¹ Claiborne County, Tenn.

[Elevation, 1,250 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total for the driest year	Total for the wettest year	Average snowfall
	° F	° F.	° F.	Inches	Inches	Inches	Inches
December.....	36.5	70	-29	4.85	2.54	2.20	2.6
January.....	35.2	71	-13	4.44	2.14	4.85	4.4
February.....	36.8	75	-7	4.19	1.04	6.07	3.4
Winter.....	36.2	75	-29	13.48	5.72	13.12	10.4
March.....	44.5	81	3	5.22	3.39	6.73	2.0
April.....	54.7	95	14	4.36	3.91	5.63	.1
May.....	62.5	98	29	4.26	.50	3.73	0
Spring.....	53.9	98	3	13.84	7.80	16.09	2.1
June.....	71.7	104	34	4.38	4.16	5.81	0
July.....	74.3	106	44	4.32	9.05	8.20	0
August.....	73.1	99	41	4.96	3.12	10.96	0
Summer.....	73.0	106	34	13.66	16.33	24.97	0
September.....	67.7	101	31	3.23	.26	2.35	0
October.....	56.6	90	16	2.97	3.08	2.32	(?)
November.....	43.2	80	6	3.03	2.08	1.26	.9
Fall.....	55.8	101	6	9.23	5.42	5.93	.9
Year.....	54.7	106	-29	50.21	³ 35.27	⁴ 60.11	13.4

¹ Formerly New Tazewell.
² Trace.

³ In 1941.
⁴ In 1909.

WATER SUPPLY

Springs are numerous in the limestone valleys and along the perennial streams in the cherty ridges, and in those areas they furnish an adequate water supply for livestock and family use. Springs also provide the home water supply in the shale ridges, although some wells are used. Water for many of the permanent pastures is provided by the small perennial streams and, during periods of heavy rainfall, by intermittent streams. In the higher cherty ridges cisterns are the chief source of water for family use, and ponds furnish water for livestock. Droughts long or severe enough to cause shortage of water for livestock or home use are uncommon, although some small streams and springs cease flowing during the dry summer and fall months. Good fishing and excellent boating and swimming facilities of the Norris Reservoir attract sportsmen from a wide area.

VEGETATION

The Norris area is in the southern hardwood belt and was originally covered chiefly with deciduous forest. The most common association of trees was chestnut, oak, and tuliptree (yellow-poplar) (9), but because of different soil and moisture conditions, there were, and still are, rather wide local variations in the kind of forest cover and the density of stand. Although the entire area has been logged and the better classes of timber cut, about 50 percent of it is still in forest. Problems relative to the management, use, and conservation of the timber resources of the area are discussed in the section on Forests.

ORGANIZATION AND POPULATION

The first white settlements in the Norris area were made about the time Tennessee was admitted to the Union. Anderson County was organized in 1801, Campbell in 1806, and Union in 1853 (11). Union County was formed from parts of Anderson, Campbell, Claiborne, Grainger, and Knox Counties. The early settlers of the area migrated principally from North Carolina, South Carolina, Virginia, Kentucky, and nearby counties in Tennessee. The present population is dominantly native white and largely descendants of the early settlers.

The population is largely rural and rather uniformly distributed on all the land except that now in the Norris Reservoir area and that on the steep ridges in the ridge and valley area. The government-owned land in the reservoir area is temporarily withdrawn from agricultural use, and the ridges of the other area are too steep for crops. Nearness to towns and main highways influences the distribution of rural population, but the character of the land is a dominant factor. The sparse population is a direct reflection of the low productivity and other unfavorable conditions of the land, but it does not follow that the best lands are the most densely populated. In this area the lands intermediate in productivity largely support small farms, and the number of people per square mile is greater than on the choice lands of Powell and other limestone valleys where agriculture is to a greater extent commercialized and individual land holdings are large.

Population figures for the Norris area are not available, as it includes only parts of Anderson and Campbell Counties. Union County,

entirely within the area, had a population of 8,670 in 1950. La Follette (population 5,797) is the largest town. Maynardville and Jacksboro are other leading towns in the area.

INDUSTRIES

Other than agriculture the area has few industries. Small garment factories are in La Follette, but the number of employees is small. Marble has been quarried to some extent. Small deposits of iron, lead, zinc, and barite have been found, but they are largely undeveloped. A considerable number of people in and around La Follette work in the nearby Cumberland Mountain coal mines.

TRANSPORTATION AND MARKETS

The Louisville and Nashville Railroad crosses the extreme northwestern corner and serves Jacksboro and La Follette. A branch of the Southern Railway crosses the extreme southeastern corner of the area. Both lines are of importance in obtaining supplies and in shipping produce to market. Federal Highway No. 25W, a hard-surfaced road, crosses the northwestern corner, and there are two paved State highways, one through the northern and one through the southern part.

Numerous gravelled all-weather roads are well distributed over the area, and practically all localities are accessible. The Central Peninsula is somewhat isolated because the waters of Norris Dam have flooded and disrupted the road systems that followed or crossed the valleys. In 1940, 128 Union County farms were on hard-surfaced roads, 895 on gravel roads, 112 on improved dirt roads, and 235 on unimproved dirt roads. Generally, road-building or surfacing materials are readily accessible near the unimproved roads.

Jacksboro, the county seat of Campbell County, and La Follette serve as markets and shipping points for the northwestern part of the area. Maynardville, the county seat of Union County, is the leading town and trading center for the southern third of the area, or that part lying south of the Clinch River. Other trading centers available to this part are Tazewell and Knoxville, both outside the Norris area. The market centers for the Central Peninsula, or that part lying between the Powell and Clinch Rivers, are Maynardville, Tazewell, and Knoxville.

Some of the farm products are marketed within the area, but most go to outside markets. The surplus corn is sold to local mills and dealers. Beef cattle and hogs are marketed through local buyers or shipped to Knoxville by truck. Poultry and eggs are disposed of through local stores, produce dealers, or travelling rural stores. The small acreages of tomatoes raised north of the Powell River, and on Copper, Chestnut, and Wallens Ridges, are sold to nearby canneries. Wheat, potatoes, sweetpotatoes, snap beans, and other miscellaneous farm products are sold for local consumption. Milk production is largely for the retail trade in La Follette, Jacksboro, and Maynardville, but small quantities go to nearby points. Most of the tobacco crop is marketed in Tazewell, Morristown, or Knoxville.

SCHOOLS, CHURCHES, AND HOME IMPROVEMENTS

Practically all farms are near elementary and high schools or are on school bus routes. There are no institutions for higher education in the area, but Lincoln Memorial University, at Harrogate, and the University of Tennessee, at Knoxville, are both nearby. Churches are in all the villages, and small country churches are in all localities.

The types of farm structures and their state of repair generally reflect soil productivity and land conditions. Farm homes in the limestone valleys are usually large well-kept brick or frame buildings; in areas on the cherty ridges, where the soils are productive, neat frame houses are common; and in the steep cherty-ridge and shale-ridge country, farm homes are generally small and resemble the pioneer type of dwelling.

AGRICULTURE

A crude simple agriculture was carried on by the Indians of the region now included in the Norris area. They raised Indian corn and beans, and later, apples, peaches, and plums (16). Wild fruits, as persimmons, grapes, papaws, mulberries, mayapples, blackberries, strawberries, and plums, were abundant.

Information on the agriculture practiced by the pioneer white men is meager, but it is apparent that it was typical pioneer farming, or that concerned primarily with the growing of subsistence crops. Corn was the principal crop, as it was well adapted to virgin land conditions, nonexacting in cultural requirements, and a staple food for man and beast. Horses, cattle, sheep, and hogs were raised only for local needs (11). A small crop of flax was grown, and clothing was made at home (21). Sugar was made from maple sap. Salt pork, potatoes, beans, turnips, corn bread, and milk were the principal foods.

Early transportation facilities were poor. Rough overland trails lead to Richmond, Baltimore, and Philadelphia; and a few easily transported items, as feathers, furs, and hides, were sold in these towns. Some heavy produce, such as corn, oats, pork, and honey, was moved on flatboats down the river to New Orleans. The completion of a road leading south in 1855 and one leading east in 1858 greatly aided the general development of the area (11).

CROPS¹

The production of subsistence crops is still a large part of the agriculture of the area, but there have been changes in the kinds and acreages. These changes are shown in table 2, which gives acreages of the principal crops of Union County in stated years.

¹The data in this section apply only to Union County but are considered representative of the entire Norris area.

TABLE 2.—*Acreage of the principal crops and number¹ of fruit trees and grapevines in Union County, Tenn., in stated years*

Crop	1919	1929	1939	1944
	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>
Corn for grain.....	20,839	14,179	8,366	6,986
Wheat.....	4,663	1,257	1,687	1,466
Oats.....	2,575	191	228	235
Rye.....	23	26	24	(²)
Barley.....	18	40	152	237
All hay.....	9,250	9,432	8,503	9,762
Timothy and clover, alone or mixed.....	5,188	6,540	1,769	2,545
Other hay.....	2,439	2,266	1,574	1,182
Alfalfa.....	52	44	311	648
Legumes cut for hay.....	1,272	439	370	(²)
Wild grasses.....	98	55	327	292
Grains cut green.....	201	88	177	368
Lespedeza.....	(²)	(²)	3,975	4,727
Silage and coarse forage.....	9,003	³ 393	⁴ 139	⁴ 88
Potatoes.....	639	501	382	370
Sweetpotatoes.....	278	216	166	204
All other vegetables.....	929	572	345	368
Tobacco.....	7	908	769	855
Sorghum.....	351	38	141	90
Apples..... trees.....	36,785	34,871	19,192	12,990
Peaches..... do.....	34,829	28,430	10,528	7,038
Pears..... do.....	1,496	2,121	1,202	1,120
Plums and prunes..... do.....	4,611	1,036	948	133
Cherries..... do.....	1,877	3,500	3,246	2,947
Grapevines.....	8,288	3,777	3,542	1,532

¹ Number of bearing fruit trees and grapevines of bearing age given for all years except 1944. The 1944 figures are for trees of all ages.

² Not reported.

³ Corn alone.

⁴ Sorghums alone.

Corn has always been the most important crop, but the acreage has been reduced, especially since 1929. The crop is grown on practically every farm in Union County and to some extent on all soils suited to row crops. The acreage for the period from 1919 to 1944 was about equal to the combined acreage of all other field crops. Although corn is grown on practically all soils, the better yields are obtained on the well-drained soils of the bottom lands. Most of it is grown on the more fertile soils the farmer has available. The corn produced is fed mainly to livestock on the farms, but some is ground in local mills for use by the farm families.

Wheat was an important subsistence crop in Union County, but as wheat from other areas became available, the acreage decreased rapidly. There were 4,663 acres in 1919, and only 1,466 in 1944. The decline, partly compensated for by increased acre yields, was probably due to several factors, including unfavorable prices, opening of the extensive wheatlands in the Middle West, and an increase in diseases and insects. Increased yields from the wheat now grown are probably due to more extensive use of commercial fertilizer, introduction of improved varieties, and better control of insects and diseases. The crop is grown in small acreages on many farms and on a wide variety of soils, but the largest acreages and the highest yields are on the more fertile soils of the limestone uplands. Most of the wheat is threshed. A part of the grain is fed to poultry and other livestock, but most of it is sold or exchanged for flour.

Tobacco has become an important cash crop in recent years. It increased from 7 acres in 1919 to 855 in 1944. Burley tobacco is grown

on small acreages in all parts of the county, most of it on Emory and Greendale soils in the cherty ridge part of the county, on Caylor soils in the limestone valleys, and on Jefferson and Leadvale soils in the sandstone and shale valleys. Most of the tobacco, the chief source of cash income on many small farms, is sold at auction in the markets at Tazewell, Morristown, or Knoxville.

The acreage of hay crops has increased somewhat since 1919. The recent increase in use of lime and phosphate has made possible the growing of more leguminous crops, particularly alfalfa, red clover, and crimson clover. Soybeans, cowpeas, crimson clover, and redtop are produced in small quantities. Lespedeza is grown on most of the soils, but alfalfa and red clover chiefly on the more productive ones in the limestone valleys. Most of the hay is fed on the farm, although a small part is sold in local and outside markets.

In 1944 oats were grown on 235 and barley on 237 acres, respectively. Part of the oat and barley crop is cut green and fed; the rest is harvested and fed to poultry and livestock. Barley, oats, and rye are now more important as winter cover and green-manure crops than they are for grain.

Potatoes and sweetpotatoes are grown on practically every farm for home use, although the acreage on each is very small. Only 370 acres of potatoes and 204 of sweetpotatoes were grown in 1944. Sorghum decreased from 351 acres in 1919 to 90 acres in 1944. The sirup is used by the farm family and the fodder is fed to livestock.

Vegetables were grown on 368 acres in 1944, and chiefly for home use. Beans, peas, turnips, onions, cabbage, beets, tomatoes, and spinach are the principal ones raised. Some tomatoes and snap beans are grown for market, but the acreage is very small.

The number of apple trees in Union County decreased from 36,785 in 1919 to 12,990 in 1944. There has been a rapid decrease in the number of peach trees since 1929. The county has no large orchard, but most farms have a few fruit trees. The production of small fruits and berries has varied from time to time but has never been important. In general, the yields of fruit are low and the quality is poor. Most of the fruits are used in the home, either fresh or preserved, but surpluses are sold in local markets.

ROTATIONS AND FERTILIZERS

Systematic rotation of crops is not commonly practiced in Union County. Land use and management practices are determined largely by the needs of the farm operator and the prices of farm products. A common practice is to grow corn, tobacco, or a like row crop for several years and then plant lespedeza or allow the land to lie idle for a few years. In places row crops are raised year after year until the natural fertility of the soil is exhausted, and the land is then abandoned. Some of the more progressive farmers use a rotation of corn or tobacco, wheat, and lespedeza. In some places red clover or alfalfa is used as the hay crop in the rotation, but these legumes are not used extensively, largely because the farmers are unwilling or financially unable to meet their exacting requirements for amendments. Educational programs and subsidies have brought about a significant increase in use of winter cover crops, but the acreage of soils unprotected in winter is still very large.

The gradual depletion of soil fertility through cropping and erosion, the clearing and cropping of less fertile soils, the education of the farmers, and the rapid increase in the growing of tobacco have all contributed to an increased use of commercial fertilizer in Union County. In 1919, 40.6 percent of the farms reported expenditure for fertilizer, whereas in 1939, 75 percent reported its purchase.

Practically all the fertilizer is bought from local dealers and is factory-mixed. Most of it is applied to tobacco, corn, wheat, and truck crops, although considerable quantities of superphosphate are used for corn, small grains, and hay. Application of 3-8-5,⁸ 3-8-6, or 2-10-4 fertilizer is made at the rate of about 200 to 800 pounds an acre on tobacco and tomato crops. Superphosphate or 0-10-14 fertilizer is applied at the rate of 75 to 200 pounds an acre to corn and small grains. In general, little attention is given to specific soil needs in determining the kinds and quantities of fertilizer used.

The use of lime has increased rapidly in recent years. In 1939, 139 farmers used 2,030 tons of lime. The lime is usually applied at the rate of about 2 tons an acre to land being seeded to a leguminous crop.

PASTURES

In 1945 there were 23,438 acres of plowable pasture in the county. The total acreage of pasture would be considerably larger if non-plowable and woodland pastures were included. Most of the permanent pastures in Union County are on soils too steep, too shallow over bedrock, or too stony for easy cultivation or they are on bottom lands too poorly drained for cultivation. The larger areas of permanent pasture are in Hickory, Raccoon, and Flat Creek Valleys. Much of the pasture is on Colbert, Armuchee, and Talbott soils and the Rolling and Smooth stony lands (Talbott soil material). The quality of pasture is somewhat variable, depending upon management; but bluegrass is the chief pasture plant. Where soil amendments have been used the pastures usually consist of bluegrass and clovers; whereas in many untreated areas, broomsedge is the dominant plant. There is a trend toward better pasture management, and many farmers are now using lime and phosphate.

LIVESTOCK AND LIVESTOCK PRODUCTS

Swine, sheep, and poultry are raised in Union County, but dairy cattle are most important. In 1945, the total number of cattle and calves on farms was 6,658, an increase of 1,489 head over 1940, and slightly more than 38 percent of this total was made up of cows milked. Most of the dairy animals are of the Jersey and Guernsey breeds, and they are kept mainly to furnish milk and butter for home use. Only 26 farms specialized in dairying in 1939; most dairying is carried on in combination with other types of farming. A few beef cattle—mainly of Hereford, Aberdeen Angus, and Shorthorn breeds—are raised, chiefly in the limestone valleys, and sold almost entirely through the livestock market in Knoxville.

The number of swine decreased from 6,323 in 1919 to 2,375 in 1945. A few hogs are grown on nearly every farm, but there are no large

⁸ Percentages, respectively, of nitrogen, phosphoric acid, and potash.

producers or breeders. Most of the pork is consumed on the farm, and the surplus is usually sold to the packing houses in Knoxville. The principal breeds are Poland China, Duroc-Jersey, and Hampshire.

Sheep have never been an important source of income in the county. The number has always been small and has been consistently decreasing. There was a decrease from 770 sheep in 1919 to 258 in 1945.

Poultry on farms consists mainly of chickens, but a few turkeys, ducks, geese, and guineas also are raised. The number of chickens kept on the farms has been extremely variable. There were 69,115 chickens in 1945, as compared to 49,940 in 1940. The principal breeds of chickens are Barred Plymouth Rocks, Rhode Island Reds, and White Leghorns; but small numbers of several other breeds are raised. Most of the chickens and eggs are collected by local buyers and then shipped to outside markets.

The number of work stock has decreased since 1920. The most rapid drop, occurring since 1930, has coincided with the decrease in number of farms. This decrease is due not only to replacement of work animals by tractors but also to the flooding of crop acreages, by Norris Lake. There were 1,177 horses and 850 mules of all ages in 1945, or an average of slightly more than 1 per farm. Practically all the work stock is raised in the county, and horses are predominantly of Belgian or Percheron breed.

TYPES OF FARMS

Of the 1,411 farms reporting in 1940, 1,138, or about 80 percent grew farm products for the use of the farm family. Of the remaining farms, 193 derived their major income from the sale of general field crops, 29 from the sale of livestock and livestock products, 7 from the sale of vegetable crops, and 10 from the sale of forest products.

The distribution of the different types of farms, either from the standpoint of size or kind of farm enterprise, is almost always a direct expression of soil and land conditions. In the steep cherty ridges and in the shale ridges where soil and land conditions are unfavorable, the farms are predominantly of the self-sufficing type. These farms are often of small total acreage and almost invariably have only small acreages of cropland.

The general farms are principally in the limestone valleys, but a few are on the smoother cherty ridges and on the better soils of the shale valleys. In all these areas there are relatively large tracts of productive soils and favorable land conditions. The livestock and dairy farms, often exceeding 150 acres, are chiefly in the limestone valleys where there is much land suited to pasture. The location of farms growing specialty crops is determined more by the interests of the farm operator than by land conditions.

LAND USE

The proportion of land in farms, the average size of farms, and the area of improved land in farms have decreased since 1920. There were 2,060 farms in 1920 as compared with 1,488 in 1945. In the same period, the average size of farms decreased from 78.3 to 66.2 acres, and the area of improved land per farm dropped from 40.1 to 31.4 acres.

The acquisition of a large acreage by the Tennessee Valley Authority has had an abnormal effect on trends in land use.

Of the land in farms in 1945, 23.2 percent was harvested cropland, 2.4 percent idle or fallow cropland, 26.1 percent plowable pasture, and 31.5 percent woodland. The rest was composed of crop failure, barn lots, home sites, lanes, roads, and land use for other purposes.

FARM EQUIPMENT AND EXPENDITURES

Heavy farm machinery is comparatively scarce in the county. Only 32 tractors and 140 motortrucks were reported on farms in 1945. Corn binders, hay loaders, side-delivery hay rakes, riding plows, combines, and such implements are scarce. Machinery on the farms of the better agricultural communities may include walking plows, one-row cultivators, one-row corn drills, small-grain drills, spike-tooth harrows, mowing machines, dump hay rakes, disk harrows, and grain binders. On the small farms there is not much machinery of any kind.

In 1945 the total expenditure for feed for livestock was \$118,486, and purchases consisted chiefly of concentrated feed for dairy cows and poultry and corn for swine. In 1939 the expenditure for fertilizer was \$22,578.

Cash wages paid for hired labor amounted to \$37,588 in 1944. The landlord generally furnishes the laborer with a house, fuel, a garden plot, and pasture for a cow. Some laborers also receive a small acreage for crops. They furnish the labor necessary in growing the crops and receive one-third of the proceeds.

SOIL SURVEY METHODS AND DEFINITIONS

In making a soil survey the soils are examined, classified, and mapped in the field and their characteristics recorded, particularly in regard to the growth of various crops, grasses, and trees.

The soils and the underlying formations are examined systematically in many locations. Test pits are dug, borings made, and highway or railroad cuts and other exposures studied. Each reveals a series of distinct soil layers, or horizons, termed collectively the soil profile. Each of these layers, as well as the underlying parent material, is studied in detail, and the color, structure, porosity, consistence, texture, and content of organic matter, roots, gravel, and stone are noted. The chemical reaction of the soil and its content of lime and salts are determined by simple tests. Other features taken into consideration are drainage, both internal and external, the relief or lay of the land, and the interrelations of soil and vegetation.

Soils that are much alike in kind, thickness, and arrangement of layers are mapped as one soil type. Some soil types are mapped in two or more phases. For example, if a soil type has slopes that range from 2 to 15 percent, the type may be mapped in two phases—an undulating phase (2 to 8 percent) and a rolling phase (8 to 15 percent); or a soil that has been eroded in places may be mapped in two or more phases—an uneroded phase, an eroded phase, and perhaps a severely eroded phase. A soil type will be broken into phases primarily because of differences in the soil other than those of kind, thickness, and arrangement of layers. The slope of a soil, the frequency of outcropping bedrock, and the extent of erosion, for example, are

characteristics that might cause a soil type to be divided into phases.

Two or more soil types may have similar profiles; that is, the soil layers may be nearly the same, but the texture, especially of the surface layer, will differ. Soil types are placed in the same series if the soil layers of each are similar in characteristics other than texture. A soil series therefore consists of soil types having layers about the same in kind, thickness, and arrangement, but different in texture, especially of the surface layer. A series may consist of one or of several soil types.

A soil series is given a geographic name taken from a place near where it was first identified. Dewey, Fullerton, Clarksville, and Muskingum are the names of important soil series in the Norris area. The name of a soil type is derived by adding to the series name the complete class name of the soil texture, as sand, loamy sand, sandy loam, silt loam, clay loam, silty clay loam, or clay. For example, Fullerton silt loam and Fullerton loam are soil types within the Fullerton series.

Fullerton silt loam illustrates the method of designating phases. This soil type is divided into four mapping units, the undulating, rolling, hilly, and steep phases. In this instance the phase indicates the relief. Fullerton silt loam, rolling phase, for example, is mildly rolling to rolling and has slopes that generally fall more than 5 but less than 12 feet in each 100 feet of distance.

Areas, such as bare rocky land or badly gullied land, that have little true soil are not designated with series and type names but are given descriptive names, such as rough gullied land or rough stony land. These are called miscellaneous land types. Rough stony land (Fullerton soil material) is such a land type in the Norris area.

The soil type, or when the soil type is subdivided, the soil phase is the unit of mapping. Because types or phases are more nearly uniform than broader groups or classes of soils, more definite statements about their use and management can be made. One can say, for example, that the soils of the Fullerton series need lime for alfalfa. More specifically it can be said that Fullerton silt loam, undulating phase, has very mild slopes and, in addition to needing lime, is suited to intertilled or row crops in a rotation with small grain and hay; whereas Fullerton silt loam, steep phase, is so difficult to conserve and work that it is not suited to use for cropland but, where properly managed, may produce fairly good pasture.

The soil surveyor plots on a map the location of each of the soil types, phases, and miscellaneous land types. In the Norris area, aerial mosaics, made by fitting together several individual aerial photographs into a single map, were used as base maps. These maps were on a scale of 1:24,000, which is equal to 2.64 inches to the mile. The soil surveyor mounted a section of a map on a small plane table equipped with a magnetic compass and, traveling on foot, systematically traversed the area represented by his map. As he traveled he made frequent examinations of the soil and plotted on his map the boundaries of each soil unit as it occurred in relation to roads, houses, streams, lakes, and other local cultural and natural features of the landscape. When the field work was completed the field sheets were assembled, and from them a single large map of the entire area was drafted. Lithographic plates were made from this map, and the colored map at the end of this report was printed from these plates.

Some terms have special meaning in soil science. For example, texture refers to the relative amounts of clay, silt, and various grades of sand making up the soil mass. Light-textured soils contain much of the coarse material (sands), and heavy-textured soils contain much fine material (clay). Structure refers to the natural arrangement of the soil material into aggregates, or structural particles or masses. Consistence refers to the relative mutual attraction of the particles in the whole soil mass or their resistance to separation (as evidenced in cohesion and plasticity); and it is described by such general terms as loose or open, slightly, moderately, or very compact, mellow, friable crumbly, plastic, sticky, soft, firm, hard, and cemented. Permeability and perviousness connote the ease with which water, air, and roots penetrate the soil.

The A horizon is the lighter textured and leached surface layer of the soil; the B horizon is the heavier textured and usually darker colored layer underlying the A horizon. The A and B horizons together form the solum, or the true soil. The C horizon is the parent material or unconsolidated weathered rock material upon which the B horizon rests. Surface soil refers to the part of the solum that is disturbed by ordinary tillage operations. The subsoil is roughly that part below plow depth.

In a practical sense reaction ⁹ may be defined as the relative richness or poverty of the soil in lime (available calcium). An acid soil is one that requires the addition of lime for maximum production of crops; a neutral soil contains sufficient lime for any commonly grown crop; and an alkaline soil is one rich in lime.

A stony or cherty soil contains enough stone or chert to interfere with but not to prevent tillage of the land. Land too stony for cultivation is designated as stony land, and land so stony that it is suitable only for the production of trees is classified as rockland.

Level land is characterized by slow surface runoff and no accelerated erosion, and heavy farm machinery can be used on it with ease. On undulating land surface drainage is adequate but moderately slow, erosion is controlled with comparative ease, and heavy machinery can be used freely. Rolling land has moderate to very rapid surface drainage, requires careful crop rotations and in places mechanical means for control of erosion, and offers moderate resistance to the use of heavy farm machinery. Hilly land has rapid surface drainage, and careful selection and rotation of crops, supplemented by mechanical devices, are necessary for control of erosion. The use of heavy farm machinery is generally impractical. On steep land surface runoff is very rapid, erosion cannot be controlled under crops, and the relief prevents the practical use of heavy farm machinery.

A soil amendment is any material added to the soil for the purpose of improving conditions for plant growth. Fertilizer, manure, and lime are soil amendments. A fertilizer is any commercially obtainable

⁹The reaction of a soil is its degree of acidity or alkalinity expressed in pH values (10) as follows:

	pH		pH
Extremely acid.....	Below 4.5	Neutral.....	6.6-7.3
Very strongly acid.....	4.5-5.0	Mildly alkaline.....	7.4-8.0
Strongly acid.....	5.1-5.5	Strongly alkaline.....	8.1-9.0
Medium acid.....	5.6-6.0	Very strongly alkaline..	9.1 and higher
Slightly acid.....	6.1-6.5		

material that contains one or more of the three essential chemical elements (nitrogen, phosphorus, and potash) in forms that crops can use in their growth processes. A mixed fertilizer contains two or more of the essential elements, and a complete fertilizer contains all three. A low-grade fertilizer contains less than 16 percent of plant foods, and a high-grade fertilizer more than 16 percent. The minor, or secondary elements, are those ordinarily in the soil, and plants require them in relatively small amounts. They include sulfur, magnesium, iron, manganese, boron, copper, and zinc. Manure, or barnyard manure, is a mixture of animal excrement, bedding, and litter that accumulates in stables. Lime is either the carbonate or hydroxide of calcium or of calcium and magnesium. It is applied primarily to neutralize soil acidity and to provide calcium for plants.

SOILS

The general characteristics of the mature upland soils in the Norris area have been determined largely by the climate and vegetation under which they formed. Their environment was one of moderately high temperature, heavy rainfall, and deciduous forest vegetation. They are characterized by a friable grayish-brown silt loam surface soil and a red or yellowish-red subsoil with a relatively large quantity of clay. The soils are highly leached and therefore low in plant nutrients and strongly acid. In general, they are lighter in color, lower in organic matter, and much more acid than the dark soils of the central United States, and, for these reasons, much less productive of crops. Nonetheless, the upland soils of this area are probably more productive than the more highly leached ones in areas farther south and southeast.

Considering the area as a whole, the general characteristics of the soils are an expression of climatic conditions and vegetation, but the individual characteristics of any particular soil reflect chiefly the kind of material from which it was developed and its age. The soils of the area have developed from parent material derived from rather large numbers and kinds of sedimentary rock; and these various kinds of rock may have a wide range of relief because of faulting, folding, and erosion. As a result of the differences in parent material, the individual soils exhibit a wide range in color, texture, consistence, depth, reaction, degree of stoniness and erosion and, accordingly, a wide range in productivity and workability.

The soils of the area vary from very light gray to brown in the surface layer and may be red, yellow, or brown in the subsoil. Texture ranges from fine sandy loam to silty clay. Most of the soils have a friable surface soil, but the subsoil ranges from mellow and friable to very sticky and tenacious. The content of organic matter is low, but the type of vegetative cover under which the soils formed and the present use and management have caused some variations. The depth of the solum ranges from a few inches to several feet, and depth over bedrock, from less than 2 feet to 50 feet or more. All the upland soils are acid, but some of the stream bottoms are neutral or slightly alkaline.

About 20 percent of the area is covered by soils classified as silt loams, 45 percent by cherty silt loams, 5 percent by silty clay loams, 5 percent by stony fine sandy loams, 10 percent by fine sandy loams, 4 percent by all other textural classes, and 11 percent by miscellaneous land types.

An estimated 50 percent of the area has undergone little or no damage by accelerated erosion, but about 1 percent of the land has been completely destroyed, and the rest has been eroded enough to reduce productivity materially and somewhat limit the use suitability.

About 44 percent of the area has steep relief; 27 percent, hilly; 23 percent, rolling; and 6 percent, level to undulating. Less than 3 percent of the area is poorly drained. About 3.7 percent of the area is composed of stone-free soils; 5 percent, stony soils; 46 percent, cherty soils, 2 percent, shaly soils; and 10 percent, soils too stony for cultivation.

About 25 percent of the area is covered by soils suited to cultivated crops, 30 percent to pasture, and 45 percent to forest. These estimates are made when the soils are grouped on the basis of their use capability, which is determined largely by the characteristics of the soils, the extent of their development, and combinations of such factors in any given soil. If the average for the Great Valley of East Tennessee is taken as a standard, it is estimated that only 3 percent of the land suited to cultivation is relatively high in productivity, 39 percent medium, and 58 percent low. The variations in soil and land conditions and the consequent suitability of the soils to various uses has largely determined the local differences in agriculture within the area.

SOIL SERIES AND THEIR RELATIONS

The soil series of the Norris area are placed in groups according to their topographic position. On this basis the four main groups are: (1) Soils of uplands, (2) soils of colluvial lands, (3) soils of stream terraces, and (4) soils of bottom lands.

The soils of uplands are on the higher lands above the stream valleys. They are underlain by consolidated bedrock from which their parent material is weathered. On the basis of differences in the kinds of underlying rock, these upland soils may be divided into four subgroups: (1) Soils of uplands derived from limestone residuum, (2) soils of uplands derived from cherty and sandy dolomitic limestone, (3) soils of uplands derived from interbedded limestone and shale residuum, and (4) soils of uplands derived from acid sandstone and shale residuum.

The soils of colluvial lands are on sloping fans and benches on the foot slopes of hills and in the bottoms of lime sinks and depressions. Their parent material is derived from soil materials and rock fragments washed and rolled from the immediately adjacent upland slopes. Two subgroups based on differences in the general character of the parent materials are recognized: (1) Soils of colluvial lands derived chiefly from materials washed from uplands underlain by limestone and dolomite; and (2) soils of colluvial lands derived from materials washed from uplands underlain by sandstone and shale with some limestone influence.

The soils of stream terraces are on the second-bottom lands or benches along streams and rivers, but they are ordinarily not subject to overflow. Their parent material is derived from old stream alluvium deposited when the streams were flowing above present levels. The soils of this group are divided into two subgroups on the basis of differences in the origin of their parent material: (1) Soils of stream

terraces derived from old alluvium, chiefly limestone materials; and (2) soils of stream terraces derived from old alluvium, chiefly sandstone and shale materials.

The soils of bottom lands are on the flood plains of streams and rivers and are subject to overflow. Their parent materials are recent stream alluvium. This group is divided into subgroups on the basis of general differences in parent materials: (1) Soils of bottom lands derived from alluvium washed from limestone materials, and (2) soils of bottom lands derived from alluvium washed from sandstone and shale materials.

The groups listed include all of the true soils of the area. An additional group, miscellaneous land types, consists of areas of land that have no true soil, because of the many bedrock outcrops or severe erosion. Alluvial soils, undifferentiated, are also included with this group. They are on the bottom lands and consist of a complex pattern of imperfectly and poorly drained young soils underlain by recent alluvium from a wide variety of materials.

In table 3 all the soil series mapped in the area are listed according to groups. Some of the more important properties of the soils are tabulated, and the relations of the various soils to each other are shown.

SOILS OF UPLANDS

SOILS OF UPLANDS DERIVED FROM LIMESTONE RESIDUUM

Soils of uplands derived from limestone residuum include those of the Dewey, Talbott, and Colbert series, which are closely associated in low-lying limestone valleys.

The Dewey soils have a brown to grayish-brown silt loam surface soil and a light-red or red silty clay subsoil. The Talbott differs from the Dewey soils chiefly in having a lighter colored, more compact, more sticky, and more plastic subsoil. The Colbert soils have a gray surface soil and yellow or brownish-yellow sticky plastic silty clay subsoil. In general the depth of solum and fertility decrease from the Dewey to the Talbott and to the Colbert soils. On similar slopes, workability and conservability decrease in the same order.

SOILS OF UPLANDS DERIVED FROM CHERTY AND SANDY DOLOMITIC LIMESTONE

Soils of uplands derived from cherty and sandy dolomitic limestone are those of the Bolton, Claiborne, Fullerton, and Clarksville series. They are on the slopes and crests of the high ridges underlain by cherty and sandy dolomite and have rolling to steep relief. Their productivity, workability, and conservability range widely according to slope, degree of accelerated erosion, tilth and moisture conditions, natural fertility, and past and present use and management.

The Bolton soils have a dark reddish-brown surface soil and a dark-red subsoil. They are friable throughout. Claiborne soils differ from the Bolton in having a grayish-brown surface layer and a yellowish-brown subsoil. The substratum is also more sticky and compact. The Fullerton have a brownish-gray friable surface soil and a light-red or yellowish-red clayey subsoil. The Clarksville have a lighter gray surface soil than the Fullerton, and they are yellow rather than red in the subsoil.

The quantity of chert in the soils increases in the order in which they were just described. The Bolton soils, at the one extreme, are

TABLE 3.—Characteristics of soil series of the Norris area, Tennessee

SOILS OF UPLANDS

Series	Topographic position	Parent material	Dominant relief	Drainage		Surface soil (A horizon)				Subsoil (B horizon)			
				External	Internal	Color	Texture	Consistence	Thick-ness	Color	Texture	Consistence	Thick-ness
Colbert	Valley troughs	Residuum from— Clayey limestone	Undulating and rolling	Moderate	Slow	About 5 inches of gray silty clay loam underlain by brownish-yellow silty clay				bedrock at about 24 inches.			
Talbot	Valley troughs and valley slopes	Slightly clayey limestone	do.	do.	do.	Grayish brown	Silt loam	Moderately friable	6-8	Yellowish red	Silty clay	Very firm	18-24
Sequoia	Valley slopes	Interbedded limestone and shale	do.	do.	do.	do.	do.	Friable	6-10	Reddish-yellow	Silty clay loam	Firm	18-24
Dewey	do.	High-grade or moderately cherty limestone	do.	do.	do.	Brown	do.	do.	8-10	Red	Silty clay	do.	24-36
Bolton	High round-topped cherty ridges	Cherty and sandy dolomitic limestone	Rolling to steep	Rapid	do.	Brown or dark-reddish brown	do.	Mellow	12	Reddish brown to dark red	Silty clay loam	Friable	36-48
Claiborne	do.	do.	Hilly and steep	do.	do.	Grayish brown to brown	do.	Friable	10-12	Yellowish brown	do.	Moderately friable	20-30
Fullerton	do.	do.	Rolling to steep	do.	do.	Brownish gray	Cherty silt loam	do.	8-10	Yellowish red	do.	do.	24-30
Clarksville	do.	do.	Hilly and steep	do.	Rapid	Light gray	do.	Loose	8-10	Brownish yellow	Cherty silty clay loam	Firm	16-28
Armuchee	Cone-shaped knobs and steep ridges	Interbedded shale and limestone	do.	Very rapid	Moderate	Grayish-brown silt loam underlain by brownish-red or yellowish-red silty clay mixed with partly weathered shale fragments.							
Montevallo	do.	Acid shale	do.	do.	Rapid	Brownish-gray shaly silt loam; bedrock at 12 to 24 inches.							
Lehew	Comby ridges	Interbedded shale and sandstone	do.	do.	do.	Purplish-brown fine sandy loam mixed with shale and sandstone fragments; bedrock at 12 to 30 inches.							
Hector	Even-crested high ridges and mountains	Massive sandstone and conglomerate; some shale	Steep	do.	Moderate	Grayish-brown loose fine sandy loam underlain by reddish-brown friable fine sandy clay loam.							
Muskingum	do.	do.	Hilly and steep	do.	Rapid	Shallow soil; brownish-gray stony fine sandy loam underlain by brownish-yellow fine sandy clay loam; bedrock at about 24 inches.							

SOILS OF COLLUVIAL LANDS

Emory	Foot slopes and bottoms of lime sinks	Local slope wash from— Bolton, Claiborne, Talbot, and Dewey soils.	Nearly level to gently sloping	Moderate	Moderate	Mellow to friable brown heavy silt loam 3 to 5 feet deep.							
Ooltawah	do.	Talbot, Dewey, Fullerton, and Clarksville soils.	Nearly level, depressional	Very slow	Slow	Grayish-brown silt loam underlain by mottled gray silt loam or silty clay loam.							
Greendale	do.	Clarksville and Fullerton soils.	Nearly level to sloping	Moderate	Moderate	Grayish-brown silt loam underlain by brownish-yellow light silty clay loam; cherty.							
Caylor	Valley fans and foot slopes	Armuchee, Talbot, Lehew, and Muskingum soils.	do.	do.	do.	Brown	Silt loam	Mellow	8-12	Yellowish-brown or brownish-yellow	Silty clay loam	Friable	20-30
Leadvale	do.	Montevallo and Lehew soils.	Gently sloping to sloping	Moderately slow	Moderately slow	Brownish gray	do.	Friable	8-12	Brownish yellow	do.	Moderately friable	12-18
Allen	do.	Muskingum soils.	Sloping	Moderate	Moderate	Grayish brown	Loam	do.	6-10	Reddish brown to yellowish red	Fine sandy clay	do.	About 20
Jefferson	do.	do.	Gently to strongly sloping	do.	do.	Brownish gray or yellowish gray	Fine sandy loam	Loose	8-10	Brownish yellow	Sandy clay loam	Friable	20-30

SOILS OF STREAM TERRACES

Cumberland	Level to sloping stream terraces	Old alluvium chiefly from— Limestone with some shale	Gently sloping to sloping	Slow	Moderate	Brown	Silt loam	Friable	8-12	Reddish brown	Silty clay or silty clay loam	Friable to firm	30-40
Capshaw	do.	do.	do.	Moderate	Moderate to slow	Grayish brown	do.	Mellow	6-10	Yellowish brown or brownish yellow	Silty clay loam	Firm	24-36
Sequatchie	do.	Acid sandstone with some limestone and shale.	do.	do.	Moderate	Light brown to grayish brown	Fine sandy loam	Very friable	8-12	Yellowish brown to brownish yellow	Fine sandy clay loam	Friable	12-20
Tyler	do.	Acid shale	Nearly level to slightly depressional	Very slow	Very slow	Gray; mottled	Silt loam	Friable	6-8	Gray; mottled	Silty clay loam to silty clay	Plastic	24-36

SOILS OF BOTTOM LANDS

Roane	Flood plains of stream valleys	Young stream alluvium from— Cherty dolomite or dolomitic limestone.	Nearly level	Moderate	Slow	Young soil; light-brown or grayish-brown silt loam underlain by cemented cherty layer at 10 to 24 inches.						
Lindsie	do.	Limestone and dolomite	do.	Very slow	do.	Young soil; brown silt loam 8 to 15 inches thick; underlain by gray mottled material.						
Pope	do.	Acid sandstone and some acid shale.	do.	Moderate	Moderate	Young soil; grayish-brown fine sandy loam.						
Philo	do.	do.	do.	Very slow	Slow	Young soil; brownish-gray fine sandy loam underlain by gray mottled fine sandy loam at 12 to 18 inches.						

practically chert-free; the Clarksville, at the other, are generally very cherty. The content of lime, organic matter, and mineral plant nutrients decreases in the same order. In general, the soils of this subgroup are less fertile than those of the limestone valley, but good tilth is ordinarily more easily maintained and, on similar slopes, erosion is less severe and the soils are less susceptible to further erosion.

SOILS OF UPLANDS DERIVED FROM INTERBEDDED LIMESTONE AND SHALE RESIDUUM

The Armuchee series, on the lower ridge slopes, and the Sequoia series, in low valleys, are included in the soils of uplands derived from interbedded limestone and shale residuum.

The Armuchee soils, underlain by interbedded limestone and shale, have a grayish-brown surface layer and a yellowish or reddish subsoil. The slopes are hilly and steep, and bedrock is at shallow depths. The Sequoia soils, underlain by similar materials, differ from the Armuchee in having milder slopes, thicker more strongly developed soil layers, and a greater depth to bedrock. In general, soils of both these series are higher in content of lime and organic matter and in fertility than those on comparable slopes in the cherty ridge sections, but lower in these than limestone valley soils.

SOILS OF THE UPLANDS DERIVED FROM ACID SANDSTONE AND SHALE RESIDUUM

The upland soils derived from acid sandstone and shale residuum include those of the Lebew, Montevallo, Hector, and Muskingum series. All are underlain by acid rock strongly resistant to weathering, and they have hilly and steep slopes and shallow profiles. Probably they are lower in natural fertility than other upland soils of the area. This subgroup covers a large acreage, but little of the land is suited to either crops or pasture.

The Montevallo are brownish-gray thin shaly soils on hilly and steep knobs underlain by green, yellow, purple, red, and gray fissile acid shale. The Lebew soils are on steep sharp-crested valley ridges underlain by purple, red, and green interbedded sandstone and shale. Although not uniform in color as mapped, the Lebew soils are dominantly purplish-brown fine sandy loams. The Muskingum are shallow sandy soils with a brownish-gray surface layer and a yellow subsoil. They occur on mountain slopes underlain chiefly by massive sandstone and conglomerates, but in some places, by acid shales. The Hector soil, also shallow and sandy, is underlain chiefly by sandstone. It differs from the Muskingum soils in having a grayish-brown surface soil and a reddish-brown subsoil.

SOILS OF COLLUVIAL LANDS

SOILS OF COLLUVIAL LANDS DERIVED FROM MATERIALS WASHED FROM UPLANDS UNDERLAIN BY LIMESTONE AND DOLOMITE

Soils of colluvial lands derived chiefly from materials washed from uplands underlain by limestone and dolomite include those of the Emory, Greendale, and Ooltewah series. They have formed in lime sinks, on foot slopes, or on sloping benches along the small intermittent streams, and they occur in both the cherty ridge areas and the limestone valleys. The soils of this group do not have well-developed profiles. Although the total acreage is small, these soils are very important to the agriculture because they are medium to high in fer-

tility and easily worked and conserved. Most of them are suited to intensive use, and high yields of crops can be obtained under good management.

The Emory is a well-drained, fertile soil with a brown surface layer and a brownish or reddish subsoil. The Greendale soils are also well drained, but they have a gray or grayish-brown surface soil and a brownish-yellow subsoil. Some angular chert fragments are on the surface and in Greendale soil. The Ooltewah has a grayish-brown surface layer and a mottled gray subsoil.

SOILS OF COLLUVIAL LANDS DERIVED FROM MATERIALS WASHED FROM UPLANDS UNDERLAIN BY SANDSTONE AND SHALE WITH SOME LIMESTONE INFLUENCE

Soils of colluvial lands derived chiefly from materials washed from uplands underlain by sandstone and shale with some limestone influence are those of the Caylor, Allen, Jefferson, and Leadvale series. They occur chiefly in the limestone and shale valleys. A part of the Jefferson soil, however, is at the foot of the Cumberland escarpment. All are on foot slopes and benches, and their parent materials have washed or rolled from the adjoining uplands. The total acreage of these soils is small, but because of medium to high fertility and good workability and conservability, they are important to the agriculture of the area. They are generally suited to a wide variety of crops, and yields are high under good management.

The Caylor soils are developed from mixed materials washed from uplands underlain by sandstone, shale, and limestone. They have a brown silt loam surface soil and a yellowish-brown silty clay loam subsoil. The Allen soil is derived from similar materials, but contains less limestone, and is older and more leached. It is also lighter in texture and has a grayish-brown surface soil and a reddish-brown subsoil. The Leadville soils have formed from materials washed almost entirely from acid shales. They have a light brownish-gray surface soil, a brownish-yellow subsoil, and a hardpan at a depth of about 3 feet. The Jefferson soil is derived from acid sandstone materials and has a brownish-gray surface soil and a brownish-yellow subsoil, both of which are stony.

SOILS OF STREAM TERRACES

SOILS OF STREAM TERRACES DERIVED FROM OLD ALLUVIUM, CHIEFLY LIMESTONE MATERIALS

The soils of stream terraces derived from old alluvium, chiefly limestone materials, are those of the Cumberland and Capshaw series. They are on terraces along the small streams in the limestone valleys and were developed from material washed largely from uplands underlain by limestone. The soils differ in their use suitability and management requirements but are fairly well suited to crops. They are of relatively little agricultural importance because of their small extent.

The Cumberland soil is on gently sloping or sloping, well-drained terraces. It has a brown surface soil and a comparatively heavy red or reddish-brown subsoil. The Capshaw soil is on gently sloping to sloping imperfectly to moderately drained terraces and has a grayish-brown surface soil and a yellowish-brown or brownish-yellow subsoil.

SOILS OF STREAM TERRACES DERIVED FROM OLD ALLUVIUM, CHIEFLY SANDSTONE AND SHALE MATERIALS

The soils of stream terraces derived from old alluvium chiefly from sandstone and shale materials are those of the Sequatchie and Tyler series. Their parent materials were washed largely from uplands underlain by acid sandstone and shale. The acreage is small.

The Sequatchie soil is well suited to crops and is of considerable agricultural importance. It is well-drained, but subject to overflow at infrequent intervals. The friable fine sandy loam surface layer is grayish brown, and the subsoil is yellowish brown. The Tyler soil is fairly well suited to pasture but very poorly suited to growing crops because it occupies level or depressed positions and is poorly drained. It has a light-gray surface soil and a gray subsoil.

SOILS OF BOTTOM LANDS**SOILS OF BOTTOM LANDS DERIVED FROM ALLUVIUM WASHED FROM LIMESTONE MATERIALS**

Soils of bottom lands derived from alluvium washed chiefly from limestone materials are those of the Roane and Lindside series. They are on the first-bottom lands along the small streams, and their parent materials were washed largely from uplands underlain by limestone and dolomite. Although they are moderately fertile, drainage and susceptibility to overflow limits their use suitability.

The Roane soil is a well-drained brown soil derived from parent material washed largely from uplands underlain by cherty dolomite or dolomitic limestone. It has cemented cherty layers at variable depths. The Lindside soil is imperfectly drained, has a brown surface layer and a gray subsoil, and is derived from mixed limestone and dolomite materials.

SOILS OF BOTTOM LANDS DERIVED FROM ALLUVIUM WASHED FROM SANDSTONE AND SHALE MATERIALS

Soils of bottom lands derived from alluvium washed chiefly from sandstone and shale materials include those of the Pope and Philo series. Though at least fairly well suited to crops, these soils, as a whole, are less productive than comparable ones derived from limestone alluvium. They are relatively much more important to the agriculture of the area, however, partly because of their larger acreage, but chiefly because of their location in areas where the proportion of soils suited to crops is small.

The Pope soil is well-drained and has a grayish-brown sandy surface layer and a dominantly yellowish subsoil. Its parent material is washed chiefly from sandstone. The Philo soil is imperfectly drained and has a brownish-gray fine sandy loam or silt loam surface soil and a mottled gray subsoil. It is derived from parent material of both sandstone and shale origin.

SOIL TYPES AND PHASES

The soil types and phases are described in detail and their relation to agriculture, including present use and management, use suitability,

and management requirements, are discussed. In addition, the following miscellaneous land types are discussed: Alluvial soils, undifferentiated, Limestone rockland (rolling), Limestone rockland (rough), Rolling stony land (Talbot soil material), Rough gullied land (Montevallo soil material), Rough gullied land (Talbot soil material), Rough stony land (Fullerton soil material), and Smooth stony land (Talbot soil material). The location and distribution of the mapping units are shown on the accompanying soil map, and their acreage and proportionate extent are listed in table 4.

TABLE 4.—Acreage and proportionate extent of the soils in the Norris area, Tenn.

Soil	Acres	Per cent	Soil	Acres	Per cent
Allen loam	266	0.1	Hector stony fine sandy loam, steep phase	353	0.1
Alluvial soils, undifferentiated	1,207	.5	Jefferson stony fine sandy loam, rolling phase	1,209	.5
Armuchee silt loam:			Leadvale silt loam:		
Hilly phase	4,653	1.9	Rolling phase	1,879	.8
Steep phase	3,528	1.5	Undulating phase	1,078	.4
Bolton silt loam:			Lehew fine sandy loam:		
Hilly phase	946	.4	Hilly phase	1,732	.7
Rolling phase	812	.3	Steep phase	17,550	7.3
Steep phase	1,526	.6	Limestone rockland:		
Capshaw silt loam	442	.2	Rolling	1,007	.4
Caylor silt loam:			Rough	1,164	.5
Rolling phase	2,068	.9	Lindside silt loam	862	.4
Undulating phase	1,198	.5	Montevallo shaly silt loam:		
Clairborne silt loam:			Rolling phase	923	.4
Hilly phase	5,297	2.2	Steep phase	4,798	2.0
Rolling phase	2,385	1.0	Muskingum stony fine sandy loam:		
Steep phase	5,753	2.4	Hilly deep phase	476	.2
Clarksville cherty silt loam:			Steep phase	9,242	3.9
Hilly phase	11,780	4.9	Ooltawah silt loam	403	.2
Rolling phase	5,257	2.2	Philo fine sandy loam	2,597	1.1
Steep phase	38,954	16.2	Pope fine sandy loam	449	.2
Clarksville loam, rolling phase	402	.2	Roane silt loam	879	.4
Colbert silt loam, rolling deep phase	493	.2	Rolling stony land (Talbot soil material)	14,839	6.2
Colbert silty clay loam, eroded rolling phase	375	.2	Rough gullied land:		
Cumberland silt loam	140	.1	Montevallo soil material	1,573	.7
Dewey silt loam, undulating phase	40	(¹)	Talbot soil material	364	.2
Dewey silty clay loam:			Rough stony land (Fullerton soil material)	6,674	2.7
Eroded hilly phase	1,319	.5	Sequatchie fine sandy loam	1,005	.4
Eroded rolling phase	891	.4	Sequoia silt loam, undulating phase	309	.1
Eroded steep phase	486	.2	Sequoia silty clay loam, eroded rolling phase	1,709	.7
Emory silt loam, undulating phase	710	.3	Smooth stony land (Talbot soil material)	1,375	.6
Fullerton cherty loam, rolling phase	1,924	.8	Talbot silt loam, undulating phase	1,111	.5
Fullerton cherty silt loam:			Talbot silty clay loam:		
Hilly phase	20,483	8.5	Eroded hilly phase	2,076	.9
Rolling phase	8,066	3.4	Eroded rolling phase	3,704	1.5
Steep phase	24,446	10.2	Eroded steep phase	1,009	.4
Fullerton loam, rolling phase	657	.3	Tyler silt loam	119	(¹)
Fullerton silt loam:			Total	240,000	100.0
Hilly phase	2,462	1.0			
Rolling phase	4,478	1.9			
Steep phase	1,078	.4			
Undulating phase	285	.1			
Greendale silt loam:					
Rolling phase	1,435	.6			
Undulating phase	1,290	.5			

¹ Less than 0.1 percent.

Allen loam.—This moderately fertile soil has a brown surface layer and a reddish-brown subsoil derived from local alluvium and coluvium. It is on well-drained terracelike fans and benches in the limestone valleys. The parent material is chiefly from acid sandstone and shale, but in places there is some limestone influence. In some places there are fragments of sandstone on the surface and in the soil. In most places the soil is underlain by high-grade limestone at a depth of 3 to 10 feet. The soil had a forest cover of oak, hickory, dogwood,

and possibly shortleaf pine. Slopes range from 2 to 15 percent. Both surface and internal drainage are moderate.

This soil is in small- or medium-sized areas mainly in Powell Valley and is associated in a complex pattern with Caylor and Jefferson soils on the colluvial lands and with the Talbott soils in the uplands. Muskingum soils are on the adjoining mountain slopes.

Following is a profile description:

- 0 to 9 inches, grayish-brown to brown friable loam with fine crumb structure.
- 9 to 14 inches, light-brown to yellowish-red friable fine sandy clay loam.
- 14 to 30 inches, yellowish-red to reddish-brown moderately friable fine sandy clay or sandy clay loam having well-developed nut structure.
- 30 inches +, yellowish-red mottled soil material and sandstone and shale fragments.

Allen loam is relatively low in organic matter; medium to strongly acid; and permeable to air, roots, and moisture. Tillage can be accomplished over a moderate range of moisture conditions, and good tilth is fairly easily maintained. The soil is moderately absorptive and retentive of moisture but is less so than the associated Caylor soils, and crops may be injured by extended drought. In the more severely eroded areas much of the original surface layer is missing and the heavier subsoil material is turned by the plow. In these places fertility and humus contents are lower and good tilth and moisture conditions are more difficult to maintain.

The soil includes several variations. The texture of the surface soil ranges from a fine sandy loam to a silt loam, with corresponding variations in the subsoil. Apparently the heavier textured part includes considerable limestone material, whereas the lighter textured part is derived almost entirely from sandstone. On a few of the stronger slopes all the original surface soil has been lost through accelerated erosion, and the upper subsoil is now at the surface. The colluvial deposit from which the soil developed is 3 to 10 feet deep. Variations, though generally not significant, may cause local differences in management requirements.

Present use and management.—Allen loam is generally used and managed in a manner only fairly well adjusted to its physical properties. Much of it is used rather intensively; and as with other soils in the limestone valleys, management practices are not designed to compensate for soil deficiencies. Practically all the soil is cleared and used mainly for corn, lespedeza hay, and small grains. Small acreages are used for tobacco and pasture, and a few of the more severely eroded areas are in permanent pasture of lespedeza and wild grasses.

Most farmers use a rotation of corn or tobacco, small grain, and hay, chiefly lespedeza but in some places red clover. As on most other soils, burley tobacco is heavily fertilized with a high-grade complete commercial mixture. Corn and small grains receive small applications of low-grade materials, and hay and pasture crops are not fertilized. A small part of the soil is limed at fairly regular intervals. No special practices for preventing erosion and conserving soil moisture are used.

About 35 percent of the soil is in corn, 35 percent in legume and grass hay crops, 20 percent in small grain, and 10 percent in other crops or idle. Under prevailing management practices, corn yields about 28

bushels an acre; wheat, 16 bushels; tobacco, 1,125 pounds; timothy and clover, 1.4 tons; and lespedeza, 1 ton.

Management requirements.—Good management for Allen loam is somewhat exacting. Proper choice and rotation of crops, use of lime and fertilizer, and control of runoff are necessary. A rotation including a row crop once in 3 or 4 years is well suited to the soil. Legumes, including red clover, crimson clover, and alfalfa, do well on the soil; and inasmuch as they are effective in increasing humus and nitrogen and in improving tilth and moisture conditions, they should have an important place in the rotation. Lime applied in small to moderate quantities at moderately frequent intervals is necessary to insure success with legumes.

Fertilization requirements are similar to those of the associated upland and colluvial soils. Tobacco requires moderate to large quantities of high-grade fertilizer having a high content of phosphorus and potash. Small grains and corn need a complete fertilizer containing medium quantities of nitrogen and potash and large quantities of phosphorus. Legumes require relatively large quantities of potash and phosphorus but no nitrogen. Contour tillage is a good practice, and in some places properly constructed broad-base terraces are helpful in preventing erosion and conserving soil moisture.

Under good management, corn yields about 43 bushels an acre; wheat, 23 bushels; lespedeza, 1.5 tons; and burley tobacco, 1,275 pounds.

Alluvial soils, undifferentiated.—As it is essentially a complex of imperfectly and poorly drained soils on the narrow bottom lands of small streams, this land type generally is not suited to crops, but it is fair to good pasture land. The parent material is young stream alluvium and some colluvium from uplands underlain by limestone, cherty dolomitic limestone, acid shale, and sandstone. The original forest cover was hardwoods. The slope range is 0 to 3 percent. Drainage is slow to moderate both externally and internally.

Small tracts of this land type are along streams in all parts of the area. In the cherty ridges it is associated with Clarksville and Fullerton soils of the adjoining uplands; in the shale or sandstone ridges with Montevallo or Muskingum soils; and in the limestone valleys, with various soils, including those of the Dewey and Talbot series and the Rolling and Smooth stony lands (Talbot soil material).

In the cherty ridge areas this land type consists chiefly of cherty Lindside soil, with small spots of Greendale and Roane soils in places. In the limestone valleys and in the shale ridges it is a complex of poorly and imperfectly drained alluvial and colluvial soils that do not fit well into any other classification unit.

The surface soil is a brownish or grayish silt loam or fine sandy loam. The subsoil is gray in most places and varies widely in texture. In general this land type is strongly acid, and it is apparently low in organic matter. Moisture conditions are poor to fair. Chert, limestone, sandstone, and shale fragments are on the surface and in the soil in many places. As this is a complex of soils, its outstanding characteristic is variability in color, texture, drainage, stoniness, and source of parent material.

Present use and management.—A small part of Alluvial soils, undifferentiated, is in forest. Most of the cleared area in the cherty ridge

sections is used for pasture, but in other places various crops may be grown. No special management practices are used on the soils. Pastures are poor to fair, both as to quality and quantity, and yields of crops are low.

Management requirements.—The use suitability of Alluvial soils, undifferentiated, varies from place to place, and so do its requirements for good management. The small better drained areas may be useful as cropland, but the profitability of such use will depend on local farm conditions. Where the soils are used for crops, the management practices described for Lindsides silt loam are probably applicable. Much of the land is suited only to pasture, however, and management practices will be concerned with pasture.

Armuchee silt loam, hilly phase.—This shallow grayish-brown soil occurs on ridge slopes. It was formed from parent materials weathered from interbedded limestone and shale under a mixed hardwood forest of oak, hickory, dogwood, walnut, beech, and maple. Slopes range from 15 to 30 percent. Surface drainage is rapid, and internal drainage is moderate.

The largest acreage is in Texas Valley, but there are also areas in Raccoon, Beard, Potato, and Flat Creek Valleys and at the base of the Cumberland escarpment in Powell Valley. In most places this soil is in long narrow tracts that separate the soils of the shale or sandstone ridges from those of the limestone valleys.

Following is a profile description:

- 0 to 12 inches, light-brown or grayish-brown friable heavy silt loam.
- 12 to 24 inches, brownish-red or yellowish-red sticky plastic silty clay interbedded with partly weathered green or yellow shale.
- 24 inches +, calcareous shale bedrock interbedded with thin layers and lenses of limestone.

The surface layer may contain small fragments of partly weathered shale and in some places fragments of sandstone that have rolled down from the crests of the ridges. Under grass sod, the upper inch or two may contain considerable organic matter, otherwise the amount is low. The soil is strongly acid and moderately absorptive and retentive of moisture.

That part of the original surface layer lost through erosion varies considerably. This layer is almost completely missing from land that has been used for growing crops, but little is gone from land used principally for pasture. In the eroded areas the remnants of the original surface layer are mixed with the subsoil in the plow layer and the surface soil is therefore a yellowish-brown silty clay loam. The proportion of limestone material in the soil varies from 25 to about 75 percent.

Present use and management.—The use of Armuchee silt loam, hilly phase, is fairly well adjusted to its physical suitability, but management practices are not designed to conserve the soil or correct its deficiencies. Use and management are probably more uniform than for any other agricultural soil of the area. An estimated 50 percent of the soil is now in forest. Practically all of the rest is used for pasture, although a small acreage is in corn. Present pastures are a mixture of wild and tame grasses and legumes, including broomsedge,

bluegrass, common lespedeza, and white clover. Few farmers use either lime or fertilizer on the soil.

Management requirements.—Because of the steep slopes and shallowness, Armuchee silt loam, hilly phase, is not suited to crops. It is well suited to pasture, however, as it is moderately fertile, responsive to management, and has a readily available water supply. Kentucky bluegrass and white clover grow very well; and many other plants, including redbtop, orchard grass, lespedeza, and various clovers, can be expected to do well.

Lime is required in moderate quantities at somewhat frequent intervals. Phosphorus is needed, but the use of potash is apparently unnecessary. Fertilizer containing nitrogen may be required to establish grass sods, but if legumes are included in the pasture mixture, its continued use should not be necessary.

Grazing should be controlled to prevent injury to the pasture stand and to prevent erosion when moisture conditions are adverse. Though grazing is effective in controlling weeds, occasional clipping of pastures for weed eradication may be necessary. Shading by widely spaced walnut or black locust trees may be beneficial in places. When sods are well established, properly fertilized, and carefully grazed, other practices for preventing erosion and conserving moisture are not needed. Under such management, pastures of excellent quality and high carrying capacity are obtained. Furnishing water to grazing animals is not ordinarily a serious problem, inasmuch as there are small springs in nearly all areas.

Armuchee silt loam, steep phase.—This phase is underlain by interbedded limestone and shale and was developed under a mixed hardwood forest of oak, hickory, elm, dogwood, maple, and walnut. The soil is shallow and has steep slopes of 30 to 60 percent. A few areas have slopes of as much as 80 percent. Surface drainage is very rapid, and internal drainage is moderate.

Broad bands of this phase are on steep slopes in Texas, Raccoon, Beard, Potato, and Powell Valleys. In many places Lehew or Montevallo soils are on ridge crests above this soil; and hilly and steep phases of Talbott soils and the Rolling and Smooth stony lands (Talbott soil material) are on the lower slopes.

Following is a profile description:

- 0 to 2 inches, grayish-brown friable silt loam.
- 2 to 12 inches, light-brown friable heavy silt loam.
- 12 to 24 inches, brownish-red or yellowish-red plastic silty clay interbedded with partly weathered green or yellow shale.
- 24 inches+, green or yellow calcareous shale containing thin lenses of limestone.

Small fragments of partly weathered shale are in the soil, and narrow limestone ledges outcrop in many places. The soil is strongly acid, permeable to air and plant roots, and moderately retentive of moisture.

This soil varies in several respects. In some places a part of the upper layers may be missing and the thickness of all layers is variable. The substratum in some places may not contain the red silty clay described. The quantity of limestone in the underlying rock may range from as little as 25 to as much as 75 percent.

Present use and management.—Only about 20 percent of Armuchee silt loam, steep phase, is cleared. Much of it was formerly used for

corn and other crops, but nearly all the cleared land is now used for pasture. Present pastures are much like those for Armuchee silt loam, hilly phase, and yields and management are essentially the same.

Management requirements.—Because of its eroded condition, strong slopes, and shallowness, Armuchee silt loam, steep phase, is not suited to cropland under present conditions. Its moderate fertility and responsiveness to good management make it well suited to pasture. The management requirements are essentially the same as those of Armuchee silt loam, hilly phase, and the management practices for both soils are practically the same. They are concerned chiefly with the choice of suitable pasture plants and the correct use of soil amendments. In some places where the soil is on narrow very steep slopes and contains a low proportion of limestone material, conditions are unfavorable for pasture because of poor moisture relations, low fertility, and difficulty in grazing. Many such areas are now in forest and should remain in such use. Cleared areas should be reforested.

Bolton silt loam, hilly phase.—This is a relatively fertile acid soil on the upper slopes of cherty and sandy dolomite ridges. Slopes range from 15 to 30 percent. Both external and internal drainage are good. The soil was under a hardwood forest. The local name, "brown chestnut land," would indicate that there were originally many chestnut trees, but a few virgin areas have forests of maple, beech, and tuliptree (yellow-poplar) as well as dead chestnut, and it is probable that the soil formed under a mixed forest of this kind. The second-growth forest is a mixed stand of yellow-poplar and short-leaf pine in most places.

The largest proportionate acreages are on Hinds and Copper Ridges, but the soil is widely distributed over all parts of the cherty ridge area. The irregularly shaped tracts of variable size are associated closely with other Bolton soils and with those of the Claiborne series. Fullerton and Clarksville soils are on the rolling ridge crests above this soil in many places.

Following is a profile description :

- 0 to 12 inches, dark-brown or dark reddish-brown very friable silt loam.
- 12 to 18 inches, yellowish-brown friable heavy loam.
- 18 to 48 inches, reddish-brown friable silty clay loam containing many small dark-brown concretions and some small angular chert fragments.
- 48 inches +, red moderately friable silty clay faintly mottled with gray, yellow, and brown and having a well-developed nut structure.

In some places, there may be a few fine chert fragments on the surface and in the soil. Dolomite or dolomitic limestone bedrock is found at depths of 30 to 50 feet.

In the upper few inches, the uneroded soil is well supplied with humus. Recently cleared areas are only slightly acid; but where crops have been grown for several years, the reaction is medium or strongly acid. Good tilth is easily maintained. Most tillage operations are accomplished with ease and over a fairly wide range of moisture conditions; but some farmers report that the furrow slice does not scour from the plow moldboard, and the local name of push soil is applied. Another local name for the soil is puffy land, which would indicate that farmers recognize its friable consistence. It is absorptive of water, and surface runoff is probably less than for any other soil of the area on similar slopes. Air and water circulate freely,

and moisture conditions are excellent for crop growth. Some farmers report that in places hay and small grains are subject to frost heaving in winter.

Included in this hilly phase are variations chiefly due to differences in color of the surface soil. In many places where this phase is adjacent to areas of Claiborne soils, the boundaries between the soils are not sharp. Near the edges of a delineated area some soil may be included that is more like Claiborne soils.

Present use and management.—Bolton silt loam, hilly phase, is not exacting in its requirements for good use and good management, but present practices are usually not well adjusted to the physical character of the soil. Practically all of it has been cleared and cultivated, but about 10 percent has been abandoned to forest because continued cropping and erosion have depleted fertility and soil material. An estimated 25 percent is now used for corn, 10 percent for small grains, 10 percent for tobacco and vegetable crops, and 45 percent for hay and pasture.

Few farmers use systematic rotations. Row crops may be grown for several years in succession and then followed by hay crops or periods of rest. Corn and small grains generally receive small applications of 0-10-4 fertilizer or superphosphate and, where available, barnyard manure. Tobacco and vegetable crops are treated with heavy applications of barnyard manure and large quantities of a 3-8-6 mixture. Little of the soil receives lime. Special methods for the control of runoff, as terracing, strip cropping, or the use of winter cover crops, are not ordinarily practiced; but most tillage is on the contour.

Under common management practices corn yields about 25 bushels an acre; burley tobacco, 800 pounds; wheat, 10 bushels; lespedeza hay, 1 ton; mixed hay, 1 ton; and alfalfa, 1.8 tons.

Management requirements.—Good management of Bolton silt loam, hilly phase, is concerned chiefly with supplying lime, phosphorus, and potash; maintaining the supply of organic matter; and preventing erosion. If other management requirements are met, the soil can be conserved under a rotation that includes a row crop once in 4 or 5 years. Legumes, such as alfalfa and clover, are effective in maintaining the humus supply, and they form sods that prevent erosion. Legumes should remain on the soil for a large part of the rotation, and lime, phosphorus, and potash are needed to insure good stands. Corn, tobacco, and vegetables do well if they are properly fertilized. Tobacco and vegetables require heavy applications of complete fertilizer that contains nitrogen, phosphorus, and potash, but corn following legumes may need only phosphorus and light applications of potash. Rotations should be planned so that lime is not applied immediately before tobacco or potatoes are planted.

After row crops have been harvested the land should be seeded to cover crops to prevent soil erosion in winter. Wheat and other small grains are useful for this purpose, and good yields can be expected if moderate applications of fertilizer containing nitrogen, phosphorus, and potash are used. Stands of small grain, however, are sometimes injured by frost heaving in winter. Terracing is of doubtful value in controlling erosion, but strip cropping and contour tillage are effective on the longer slopes.

Under good management, corn can be expected to yield 35 bushels an acre; wheat, 15 bushels; lespedeza, 1.3 tons; and burley tobacco, 1,125 pounds.

Bolton silt loam, rolling phase.—Compared with other soils of the cherty ridge area, this phase is moderately high in fertility. It has a distinctive reddish-brown surface soil, is only slightly or moderately eroded, and is physically good to excellent cropland. The soil is on the rolling crests of ridges underlain by slightly cherty sandy dolomite or dolomitic limestone. It developed under a mixed hardwood forest of maple, beech, chestnut, oak, and tuliptree. Slopes range from 8 to 15 percent. Both external and internal drainage are moderate.

This phase is widely distributed throughout the cherty ridge area, but the largest proportionate acreage is on Hinds, Copper, and River Ridges. Most of it is in long narrow strips along the ridge crests associated with Claiborne, Fullerton, and Clarksville soils, and with other members of the Bolton series.

Following is a profile description:

- 0 to 12 inches, dark reddish-brown or brown very friable silt loam with a fine crumb structure.
- 12 to 20 inches, yellowish-brown friable heavy silt loam.
- 20 to 48 inches, reddish-brown moderately friable silty clay loam with a weakly-developed fine nut structure.
- 48 inches +, red slightly plastic silty clay, faintly splotched with yellow and having a well-developed nut structure.

In many places there are small fragments of weakly cemented sandstone on the surface, and in some places angular chert fragments. The local names—puffy land, push land, and brown chestnut land—indicate that many farmers recognize the more important characteristics of the soil. Bedrock is at depths of 30 to 50 feet.

The organic matter content of this soil appears to be high, as compared to other upland soils of the area. The soil is medium to strongly acid, permeable to air, water, and roots, and easily kept in good tilth. Tillage can be accomplished with ease over a wide range of moisture conditions, but the soil fails to scour from the plow moldboard under certain conditions. Moisture conditions for growth of crops are generally good; and because of the permeable absorptive qualities of the soil, water control is easily accomplished.

The chief variation in this phase is in the color of the surface soil. In many places the surface soil is brown or yellowish brown and the subsoil is generally a little lighter in color than normal. Like other soils of the Bolton series, this phase is closely associated with soils of the Claiborne series. In some places the boundary between the soils is not sharp, and small areas with profiles more like those of the Claiborne soils may be included in this mapping unit.

Present use and management.—Because it is a productive soil associated with large areas of unproductive ones, Bolton silt loam, rolling phase, is used intensively. Management practices are only fairly well adjusted to the soil. Practically all of it is cleared, and about 85 percent is under cultivation. An estimated 30 percent of the cultivated land is used for corn; 20 percent for small grain; and 30 percent for hay, principally lespedeza. The remaining 20 percent is used for other crops or left idle.

A few farmers use a rotation of a row crop, small grain, and hay; but definite cropping systems are not used on a great part of the soil.

Tobacco, corn, or vegetables are grown for several successive years and then followed by lespedeza.

Corn and small grains receive small applications of 0-10-4 fertilizer and some barnyard manure, if available. Vegetables and tobacco are fertilized heavily with 3-8-6 or a similar mixture and in many places receive additional applications of barnyard manure. Hay crops ordinarily receive no amendments. Little of this soil is limed at periodic intervals. Tillage is roughly on the contour, but other special practices for controlling runoff and erosion are not ordinarily used.

Under the common prevailing management corn yields about 28 bushels an acre; wheat, 13 bushels; burley tobacco, 1,000 pounds; mixed hay, 1.2 tons; lespedeza, 1 ton; and alfalfa, 2 tons.

Management requirements.—Maintenance of Bolton silt loam, rolling phase, is not difficult; it can be accomplished largely through the proper choice and rotation of crops and the use of soil amendments.

The soil is well suited to corn, tobacco, lespedeza, red clover, crimson clover, and small grains. It is especially well suited to vegetables because of generally prevailing good moisture conditions, good tilth, high humus content, and fertility. The soil can be conserved under a rotation that includes a row crop once in 3 years. A row crop followed by a small grain seeded with a legume makes a desirable rotation. As soon as intertilled crops are harvested a cover crop (small grain or a legume) is needed to prevent excessive runoff and erosion during winter. A legume allowed to remain for at least a year during each rotation is effective in maintaining the content of organic matter and in supplying nitrogen. Barnyard manure is also effective in this respect and in addition furnishes some potash.

Vegetable crops, burley tobacco, and legumes require liberal applications of fertilizer containing phosphorus and potash. Further increase in yields of vegetables can be obtained by using nitrogen fertilizer in addition to the potash and phosphorus. Corn and small grains need heavy applications of phosphorus and possibly potash, but lespedeza and grass hays need little or no fertilizer if other crops in the rotation receive heavy applications. Moderate to heavy applications of ground limestone at fairly long intervals are necessary to insure good stands of legumes and will probably result in increased yields of other crops.

Contour tillage should be practiced wherever possible; but where crops are properly rotated and properly fertilized, water control is not a serious problem. Well-planned, properly constructed, and well-maintained broad-base terraces, however, may be effective on the more severely eroded areas.

Under good management corn can be expected to yield about 40 bushels an acre; wheat, 20 bushels; burley tobacco, 1,300 pounds; and lespedeza hay, 1.4 tons.

Bolton silt loam, steep phase.—This reddish-brown soil occupies steep slopes of cherty ridges underlain by slightly cherty sandy dolomite or dolomitic limestone. Compared with other soils on similar slopes, this one is moderately fertile but difficult to work and conserve. It is not physically suited to crops but fairly well suited to pasture. The soil was developed under a mixed hardwood forest of

chestnut, tuliptree, beech, maple, and oak. Slopes range from 30 to 60 percent, although they are usually less than 40 percent. External drainage is rapid and internal drainage is moderate.

This steep phase is on all the cherty ridges of the area, but the largest proportionate acreage is on Hinds and Copper Ridges. Much of it is on steep slopes facing north and east that surround covelike drain heads, but it is not exclusively in such sites. It is associated with other Bolton soils and those of the Claiborne, Fullerton, and Clarksville series. In many places it is adjacent to Claiborne silt loam, steep phase, and the boundaries between the two soils are not distinct.

Following is a profile description :

0 to 8 inches, dark reddish-brown or brown very friable silt loam.

8 to 48 inches, red or reddish-brown friable silty clay loam.

48 inches+, faintly mottled red silty clay with a moderately well-developed nut structure.

A moderate quantity of cherty fragments may be on the surface. Bedrock is usually at depths of 20 feet or more, but there are a few surface outcrops in places.

The soil is medium to strongly acid, and as compared to other Bolton soils, low in organic matter. Good tilth is fairly easy to maintain, and moisture conditions are generally good, but this phase is less favorable in these respects than other Bolton soils.

This phase shows variations in color of soil material and in thickness of layers. In both factors the variation is according to degree of erosion. In some places the original surface layer is entirely missing and the present surface soil is formed by the upper part of the original subsoil. As with other Bolton soils, the surface soil is brown or yellowish-brown in some places. Some small areas with profiles similar to those of the Claiborne soils are included in this separation, as the boundary between the soils is not everywhere distinct.

Present use and management.—Bolton silt loam, steep phase, is associated with large areas of relatively unproductive soils in many places. It is fairly productive of crops but somewhat difficult to conserve. Although about 50 percent of the soil has been cleared and used for agricultural purposes, nearly a fourth of the cleared land has been abandoned and is now covered with a second-growth forest of shortleaf pine and tuliptree. About 25 percent of the soil now cleared is used for corn and 50 percent for hay and pasture. The remaining 25 percent is idle.

A definite rotation of crops is not followed. Corn may be grown for several years in succession and followed by mixed hay or pasture of lespedeza, timothy, and redtop. Some fields are allowed to grow up in broomsedge and brush, and these must be grubbed before the land can be used again for crops. Small quantities of commercial fertilizer are used on corn, but hay crops and pasture are not fertilized. Little of the soil is ever limed. Most tillage is on the contour.

Management requirements.—Although the profile of Bolton silt loam, steep phase, is similar to that of Bolton silt loam, hilly phase, its management requirements are decidedly different because of its steeper slopes. The application of lime and mineral plant nutrients, the maintenance of humus supply, and careful practices for water control are

necessary. Because the soil is generally not adequately conserved under rotations including row crops, it is best used on most farms for forage crops for hay and pasture. Lespedeza, red clover, timothy, red-top, and orchard grass are well suited to the soil, but alfalfa and bluegrass will do well only on the less eroded sites where soil and moisture conditions are most favorable. All of these crops need heavy applications of phosphorus, and legumes probably need potash in addition. Lime is required in moderate quantities at moderate intervals.

Sod-forming crops tend to increase the humus content of the soil and thereby improve tilth and increase moisture-absorbing properties. In addition, the roots are effective in binding the soil mass. These factors combined are effective in preventing excessive runoff, and where sod crops are grown continuously, no other practices for water control are needed.

Special practices for eradicating weeds in pastures are usually not needed where adequate soil amendments are used and grazing is properly managed; but in a few places clipping of pastures in spring and fall may be advisable.

Where the need for cropland makes necessary the use of this soil for row crops and small grain, a rotation of row crop followed by small grain seeded to hay is suitable. The hay is allowed to remain as many years as the farm program will permit. The requirements for lime and fertilizer under this system will be about the same as for Bolton silt loam, hilly phase. Contour tillage is essential, and contour strip cropping may be desirable.

Capshaw silt loam.—This moderately well-drained soil formed from old alluvium washed from uplands underlain chiefly by limestone and shaly limestone. The soil has developed under a mixed hardwood forest of oak, tuliptree, maple, black walnut, hickory, and dogwood. Slopes range from 2 to 10 percent. Surface drainage is moderate, and internal drainage is moderate to slow. This soil is on moderately young terraces along Big, Dossett, Davis, Buffalo, and Flat Creeks in close association with Lindside, Talbott, Sequoia, and Armuchee soils and the Rolling and Smooth stony lands (Talbott soil material).

Following is a profile description:

0 to 10 inches, grayish-brown or light-brown friable silt loam.

10 to 36 inches, yellowish-brown to brownish-yellow firm silty clay loam with a moderately well-developed nut structure; layer may be faintly spotted with yellow and gray in the lower part.

36 to 48 inches +, brownish-yellow, spotted with gray, slightly plastic or plastic silty clay.

The depth to bedrock is not less than 3 or 4 feet and is 10 feet or more in most places. A few chert fragments or gravel may be found on the surface, and gravel layers are common in the parent material. The soil is medium to strongly acid.

This soil includes several variations. An area of about 80 acres in the Powell Valley has a moderately compact subsoil and is less well drained than the profile described. The soil varies greatly in color, texture, and consistence, even along the same stream. Some of the terraces are underlain at relatively shallow depths by limestone bedrock and the soils have a gray surface soil and yellow subsoil. These variations are less productive than the normal soil.

Present use and management.—All of Capshaw silt loam is cleared and most of it is being used for field crops. An estimated 30 percent is in corn, 40 percent in hay and grasses, and 20 percent in small grains. The remaining 10 percent is in other crops or idle. A few farmers use a rotation of corn, small grain, and hay, but in most places a systematic rotation of crops is not practiced. There is some liming and fertilization, but the quantities used are not adequate to give high yields. Tobacco is fertilized heavily with a 3-9-6 fertilizer, and some farmers fertilize small-grain and hay crops with phosphate. Lime is spread on many fields before seeding legumes.

Under the present system of management corn yields about 28 bushels an acre; wheat, 13 bushels; mixed hay, 1.3 tons; and burley tobacco, 1,000 pounds.

Management requirements.—Good management of Capshaw silt loam requires the supplying of mineral plant nutrients and lime, maintenance of humus, and simple practices for the control of runoff. The soil apparently can be conserved under a rotation that includes a row crop once in 3 or 4 years. Winter cover crops, as crimson clover, rye, or winter oats, are effective in maintaining the nitrogen supply and preventing erosion on fields used several successive years for growing tobacco or vegetables. All crops require moderate to heavy applications of mineral fertilizer containing phosphorus and possibly potash. Barnyard manure is valuable as a source of humus, nitrogen, and potassium. Contour tillage is advisable, but mechanical devices for the control of runoff are not ordinarily necessary.

Under good management corn yields about 40 bushels; wheat, 22 bushels; lespedeza, 1.4 tons; and burley tobacco, 1,300 pounds.

Caylor silt loam, rolling phase.—This well-drained soil is on fans and benches in limestone valleys at the foot of mountain slopes. It is moderately fertile, fairly easy to work and to conserve, and physically good to excellent for crops. The parent material is derived from colluvium and local alluvium that have been washed and rolled from uplands underlain by sandstone, calcareous shale, and limestone. The soil was developed under a mixed hardwood forest of oak, tulip-tree, maple, black walnut, hickory, and dogwood. Slopes range from 7 to 15 percent—the larger part of the soil having slopes of less than 12 percent. Both surface and internal drainage are moderate.

Most of the soil is in Powell, Big, and Raccoon Valleys in irregularly shaped areas of small or medium size. It is associated in a complex pattern with Caylor silt loam, undulating phase, and Allen loam on the colluvial lands and with Sequatchie and Capshaw soils on the adjoining stream terraces. Dewey and Talbott soils and Rolling stony land (Talbott soil material) are on the adjoining valley uplands, and Armuchee, Lebew, Talbott, and Muskingum soils on the nearby mountain slopes.

A profile description of this soil follows:

- 0 to 12 inches, grayish-brown to brown very friable silt loam with a weakly developed granular structure.
- 12 to 36 inches, yellowish-brown to brownish- or reddish-yellow, moderately friable silty clay loam having a fairly well-developed nut structure and some small dark concretions.
- 36 inches +, brownish-yellow slightly plastic silty clay faintly mottled with red and yellow and containing small fragments of sandstone and shale.

A few small quartz pebbles are found on the surface and throughout the profile in many places. The underlying limestone bedrock is at depths of 5 to 15 feet.

The soil is medium acid and, as compared with the associated soils of the upland, moderately high in organic matter. In most places the content of humus can be easily increased. Water is readily absorbed and retained, and moisture conditions for the growth of plants are generally good. Although the soil has lost part of the original surface layer through erosion, the subsoil is turned by tillage operations in only a few places, and good tilth is easily maintained.

The soil includes several variations. Where enough of the original surface soil is missing, the upper subsoil is turned by the plow, and in consequence, the surface layer is lighter colored and heavier textured. A small area in Powell Valley has a more yellowish subsoil than normal, with some yellowish-brown mottlings in the lower part. Also included with this separation are small areas of soils developed directly from limestone residuum. These variations are of relatively small extent and do not materially alter the use suitability or management requirements of the soil.

Present use and management.—Practically all of Caylor silt loam, rolling phase, is cleared and cultivated, and use and management are fairly well adjusted to its physical properties. An estimated 35 percent is used for growing corn; 15 percent for small grains, chiefly wheat; and 35 percent for hay and forage crops. The remaining 15 percent is used for miscellaneous field crops or left idle.

The better farmers use a rotation of corn, small grain, and hay; but in some places systematic rotation of crops is not practiced, and 2 years or more of row crops are followed by hay, either lespedeza or red clover and timothy. Some fields are allowed to remain idle for a year or two after being in row crops, and following this they may be broken again for intertilled crops.

Possibly half or more of the soil is limed at fairly regular intervals. Medium to large quantities of 3-8-6 commercial fertilizer are used on tobacco by most farmers, although some may use barnyard manure and superphosphate. Corn and small grains ordinarily receive small or medium quantities of 0-10-4 fertilizer, but a few of the better farmers use larger quantities of a high-analysis material similar to that used on tobacco. Hay crops are not ordinarily fertilized, although in recent years some farmers have begun to use superphosphate in addition to lime on red clover and alfalfa.

Under present systems of management corn yields about 30 bushels an acre; wheat, 18 bushels; burley tobacco, 1,200 pounds; clover and timothy, 1.5 tons; alfalfa, 2.8 tons; and lespedeza, 1.3 tons in the average season.

Management requirements.—Caylor silt loam, rolling phase, has fairly simple requirements for good management; and these consist of proper choice and rotation of crops, application of lime, fertilizer, and other soil amendments; and use of practices for control of runoff. The soil is suited to moderately intensive use; and if other management requirements are met, it can be conserved under a rotation that includes a row crop once in 3 or 4 years. It is well suited to all the common field crops of the area, including corn, burley tobacco, soybeans, wheat, oats, barley, red clover, crimson clover, and alfalfa.

A useful 4-year rotation is one in which a row crop is followed by wheat seeded to red clover alone or to red clover mixed with timothy. Where it is feasible to leave the hay crop for 3 or 4 years, alfalfa can be used. Legumes have an important part in any rotation, inasmuch as they are effective in increasing supplies of humus and nitrogen and in improving tilth and moisture conditions. Lime applied in moderate quantities at moderate intervals is necessary to insure success with legumes. Contour tillage should be practiced everywhere, and carefully constructed and maintained broad-base terraces for controlling runoff may be useful in preventing erosion and conserving soil moisture.

Under good management, corn yields about 43 bushels an acre; wheat, 23 bushels; burley tobacco, 1,500 pounds; alfalfa, 3.6 tons; and lespedeza, 1.5 tons.

Caylor silt loam, undulating phase.—This fertile soil occurs on colluvial fans and benches with slopes of 2 to 7 percent, and is excellent cropland. Its parent material is derived from mixed colluvium that came from uplands underlain by limestone, sandstone, and calcareous shale. The soil was developed under a hardwood forest of oak, maple, black walnut, tuliptree, and dogwood. Both internal and surface drainage are moderate.

Small or medium-sized areas of this soil are in Powell Valley and small ones are in Big Valley and Raccoon Valley. In the valleys this phase is associated with Dewey, Talbott, and Allen soils and with Caylor silt loam, rolling phase. Talbott, Armuchee, Lehew, and Muskingum soils are on the adjoining mountain slopes.

Like others derived from colluvial materials, the Caylor soils are somewhat variable in profile characteristics; but this phase has a fairly well developed profile as follows:

- 0 to 12 inches, brown very friable silt loam with a fine crumb structure.
- 12 to 36 inches, yellowish-brown, brownish-yellow, or reddish-yellow moderately friable silty clay loam having a fairly well-developed nut structure and containing some small brown concretions.
- 36 inches +, brownish-yellow slightly plastic silty clay faintly mottled with red and yellow.

Most of the soil is entirely free of stones, but in a few places there are some angular fragments of sandstone on the surface and in the soil. High-grade limestone bedrock is at depths of 5 to 15 feet.

The surface layer of this soil is medium acid and, compared with the associated soils of the uplands, moderately high in humus. Good tilth is easily maintained, and tillage can be accomplished over a fairly wide range of moisture conditions. The soil is absorptive and retentive of moisture, and conditions for plant growth are generally better than in associated upland soils of comparable slopes.

Several variations are included. In a few places the layer of colluvium is thin and the lower subsoil is derived from limestone residuum. In Powell Valley the subsoil is more yellow than in the other valleys. None of these variations materially affect the use suitability and management requirements of the soil.

Present use and management.—The present use of Caylor silt loam, undulating phase, is fairly well adjusted to its physical properties, but yields can be increased by more careful management. All of it is cleared and cultivated. Corn, wheat, red clover, lespedeza, burley tobacco, and vegetables are the chief crops.

The soil is used intensively in short rotations in some places; whereas in others, definite rotations are not used, and several years of row crops are followed by several of hay. Some of the soil is limed at periodic intervals. Tobacco is heavily fertilized by most farmers with a high-analysis commercial mixture, and also with barnyard manure where available. Corn and wheat receive small to moderate applications of lower grade materials, and most hay crops are not fertilized. The prevention of erosion and conservation of moisture are not serious problems.

Under prevailing systems of management corn yields about 40 bushels an acre; wheat, 20 bushels; burley tobacco, 1,500 pounds, timothy and clover, 1.8 tons; and lespedeza, 1.5 tons.

Management requirements.—The relatively simple requirements for good management of Caylor silt loam, undulating phase, are chiefly the proper choice and rotation of crops and the use of lime and fertilizer. Corn, burley tobacco, vegetables, small grains, crimson clover, red clover, and alfalfa are among the crops suited to the soil.

Where comparatively long rotations are feasible from the standpoint of farm management, alfalfa fits well as the hay crop in a row crop-small grain-hay rotation. The soil is suited to intensive use, however, and, if other management requirements are met, it can be conserved when used for row crops every second or third year. A suitable 2-year rotation is a row crop followed by small grain seeded with crimson clover—the clover to be turned under as a green-manure crop.

Lime in moderate quantities at short to long intervals is required to insure success with legumes, which are effective in maintaining or increasing the supplies of humus and nitrogen. Barnyard manure is also a good source of organic matter, nitrogen, and potash, but it should be supplemented with phosphorus fertilizer to obtain the correct balance of plant nutrients.

Tobacco needs liberal applications of high-grade complete fertilizer containing relatively high proportions of phosphorus and potash. Corn and small grains require moderate to large quantities of similar mixtures, but the proportion of potash can be somewhat less. Legumes need large quantities of potash and phosphorus but no nitrogen. In general the fertilizer requirements of vegetables are about the same as those of tobacco. Where good tilth is maintained by careful cultivation, the use of lime, and the increase of humus, no special practices for controlling runoff other than contour tillage of steeper slopes are required.

Corn yields about 55 bushels an acre; wheat, 28 bushels; tobacco, 1,800 pounds; timothy and clover, 2 tons; alfalfa, 4 tons; and lespedeza, 1.8 tons.

Claiborne silt loam, hilly phase.—Compared with others of the cherty ridges, this is a moderately fertile soil. It is slightly cherty and has a distinctive brown surface layer. Although more fertile, less cherty, and generally less eroded than the associated Fullerton soils, it is less favorable in these characteristics than Bolton silt loam, hilly phase. It is fair cropland. The soil is on upland slopes underlain by sandy cherty dolomite or dolomitic limestone and was originally under a mixed forest of beech, maple, tuliptree, and some oak. Slopes range from 15 to 30 percent, and both internal and surface drainage are good.

The soil occurs throughout the cherty hill area, but like Bolton soils, the largest proportionate acreages are on Copper and Hinds Ridges closely associated with Fullerton and Bolton soils, and to a lesser extent, with the Clarksville. Much of it is in irregularly shaped areas near the tops of ridges, but some is in large continuous strips on slopes along intermittent streams.

Following is a profile description:

0 to 10 inches, grayish-brown or brown friable silt loam with a weak fine crumb structure.

10 to 32 inches, yellowish-brown moderately friable silty clay loam with a well-developed nut structure.

32 inches +, yellowish-red slightly plastic silty clay.

A small quantity of angular chert fragments is on and in the surface soil, and a moderate quantity that increases with depth is in the subsoil and substratum. Cherty dolomite bedrock is found at depths of 20 to 50 feet.

The soil is medium to strongly acid. Good tilth is easily maintained, and moisture absorption and circulation are favorable for plant growth. The substratum is less permeable and absorptive than the layers above, and when those layers become saturated with water during prolonged rains, surface runoff and soil erosion are greatly increased.

Variations included in this mapping separation are those caused by differences in degree of accelerated erosion, in amount of chert, and in color of surface soil. In some places much of the original surface soil is missing, and the present surface layer is a mixture of the remaining original surface soil and the upper subsoil. In these places the surface layer is heavier in texture, lighter in color, and less fertile; but good tilth and favorable moisture conditions remain fairly easy to maintain.

From one-fourth to one-third of the soil has sufficient chert on the surface and in the soil to interfere somewhat with tillage operations, but otherwise it is essentially the same as that of the rest of the phase. Variations of a more general nature are also included in this phase because it is closely associated with the Bolton and Fullerton soils and has intermediate properties. In some places the boundary between this phase and either Bolton or Fullerton soils is not clearly defined, and small areas of either or both may be included. In general the variations mentioned are not of sufficient extent to alter the use suitability or management requirements of the soil.

Present use and management.—Because it is one of the more productive soils in the cherty ridge area, Claiborne silt loam, hilly phase, is used rather intensively; and in consequence, management practices are not well adjusted to the physical properties of the soil. About 20 percent is now used for corn, 5 percent for small grain, and 40 percent for hay and pasture. Approximately 10 percent is idle, and 25 percent is in forest.

Few of the farmers practice systematic crop rotation. Corn or other row crops are grown for several years in succession and then followed by lespedeza or redtop and timothy, which are harvested for hay or used for pasture. After periods of intensive use, some of the soil is allowed to remain idle for several years, and during this time it becomes covered with brush and broomsedge. When the soil is again needed for cropping, it is cleared by grubbing and burning.

About 100 pounds of 0-10-4 fertilizer an acre are used under corn and small grains. Heavier applications of 3-8-6 or a similar fertilizer, as well as barnyard manure where available, are used on tobacco. Hay and pastures ordinarily are not fertilized. Little of the soil is limed periodically.

Average acre yields expected under common management practices are corn, 20 bushels; wheat, 10 bushels; burley tobacco, 700 pounds; and lespedeza or mixed hay, 0.9 ton.

Management requirements.—Good management of Claiborne silt loam, hilly phase, requires the proper choice and rotation of crops and correct choice and use of soil amendments, and other practices may be necessary. Where other management requirements are met, the soil can be conserved under a rotation that includes a row crop once in 5 years. Corn followed by a small grain seeded to a legume or legume-grass mixture for hay or pasture is a desirable rotation. Burley tobacco and vegetables are other row crops that can be expected to do fairly well. Red clover, alone or mixed with timothy, is effective in maintaining the supply of humus and nitrogen, and it forms a protective cover that prevents excessive runoff and soil erosion. Some of the soil may be fairly well suited to alfalfa, which is also effective in controlling water.

Medium applications of ground limestone at moderately frequent intervals are necessary to obtain good stands of legumes. In addition liberal quantities of phosphorus and potash are required. Corn and small grains need phosphorus in large quantities and some potash. Tobacco and vegetables should be heavily fertilized with complete mixtures containing small to medium quantities of nitrogen and large ones of phosphorus and potash. Barnyard manure is beneficial to all crops because it furnishes potash and some nitrogen and improves tilth and moisture relations.

Tillage should be on the contour, where practicable, but terracing as a means of erosion control is probably feasible in very few places. Strip cropping may be useful in this respect, especially on the longer slopes.

Under good management corn yields 32 bushels an acre; wheat, 15 bushels; lespedeza, 1.2 tons; and burley tobacco, 1,000 pounds.

Claiborne silt loam, rolling phase.—Like others of the series, this phase has a distinctive brown surface soil. It is moderately fertile and is good cropland. The soil is on uplands underlain by sandy cherty dolomite or dolomitic limestone and was originally under a mixed forest of beech, maple, tuliptree, and several varieties of oak. Slopes range from 7 to 15 percent. Both internal and surface drainage are good.

This phase is in the same parts of the area as other Claiborne soils. The largest tract is on Copper Ridge, but the soil occurs in long comparatively narrow strips on the tops of the ridges in all the cherty ridge area and is associated with other soils of the series and with Fullerton and Bolton soils.

The profile of this phase is essentially the same as that of the hilly phase of Claiborne silt loam, but it has been less severely eroded where cleared, and the surface soil is generally somewhat thicker. Originally the content of organic matter in the surface soil was relatively high, but it has been largely dissipated by continued cropping. The soil

is strongly acid. Good tilth is easily maintained, and tillage operations can be accomplished over a fairly wide range of moisture conditions. The water-supplying capacity is relatively high, and moisture conditions are generally favorable for plant growth.

The chief variations in the soil are those due to differences in the amount of chert and to extent of accelerated erosion. About one-fourth of the phase has sufficient chert on the surface and in the soil to interfere somewhat with tillage operations. This cherty variation is found wherever the phase occurs, and it has been indicated on the soil map by the use of chert symbols within the delineated areas.

The degree of accelerated erosion varies widely from field to field, but in only a comparatively few places is the original surface soil so eroded that the subsoil is turned by the plow or other tillage implements. As with other Claiborne soils, the boundary between this phase and either Fullerton or Bolton soils is not sharp; and small areas approaching either of those soils in properties are included. An area of 44 acres that differs chiefly in having a slope range of 2 to 7 percent is also included. None of the variations is sufficiently great to affect the general use suitability or management requirements of the soil.

Present use and management.—Practically all of Claiborne silt loam, rolling phase, is cleared and cultivated, and its use is fairly well adjusted to its physical properties. An estimated 30 percent is used for corn, 25 percent for hay, 10 percent for small grain, and 10 percent for other crops. About 25 percent is in pasture or is idle.

Systematic crop rotations are not generally followed. Corn or tobacco are grown for several years in succession and then followed by a lespedeza or grass hay crop. Some fields are left fallow or idle for one or two crop seasons at irregular intervals.

Small amounts of 0-10-4 fertilizer are used on corn and small-grain crops, but fairly heavy applications of high-grade complete fertilizer are used under tobacco and vegetables. Hay crops are not ordinarily fertilized, but they benefit to some extent from the materials applied to the preceding crops. Little of the soil is limed at periodic intervals. Almost no special measures for control of erosion and conservation of soil moisture are practiced.

Yields on this soil are slightly less than those obtained on Bolton silt loam, rolling phase. Estimated acre yields under common practices of management are corn, about 25 bushels; wheat, 13 bushels; burley tobacco 975 pounds; and lespedeza or mixed hay, 1 ton. If lime is used in addition to other common practices, yields of about 2 tons of alfalfa are obtained.

Management requirements.—Claiborne silt loam, rolling phase, is similar to the rolling phase of Bolton silt loam in requirements for good management, but some practices for controlling runoff and conserving soil moisture are also needed.

When carefully managed in other respects, this soil can be conserved under a rotation that includes a row crop once in 3 years. A row crop followed by small grain seeded to an annual legume makes a desirable rotation, or a row crop followed by a legume for 2 years may also be used if it fits well into the farm management program. Corn, burley tobacco, tomatoes, and other vegetables are among the intertilled crops that can be expected to do well. The soil is fairly well suited to all small grains.

Good stands of both red clover and alfalfa can be obtained if moderate quantities of lime are applied at periodic intervals. Both of these crops are effective in maintaining or increasing the supplies of humus and nitrogen. All crops require some potash and liberal applications of phosphorus, but legumes, burley tobacco, and some vegetables need large quantities of potash. Some vegetables need additional nitrogen in fertilizer. Barnyard manure is effective in supplying nitrogen and potash and helps maintain or improve tilth and moisture conditions, but it must be supplemented with phosphate to obtain a proper balance of plant nutrients.

Contour tillage is a desirable practice where feasible. Terraces may be useful in preventing soil erosion and conserving soil moisture, but their need should be established by careful study, and they must be properly planned and maintained to be effective.

Under good management corn yields about 38 bushels an acre; wheat, 20 bushels; burley tobacco, 1,275 pounds; lespedeza, 1.3 tons.

Claiborne silt loam, steep phase.—This phase is on steep slopes of cherty ridges and is underlain by sandy cherty dolomite or dolomitic limestone. It was developed under a mixed forest of beech, maple, tuliptree, and oak. The soil is moderately fertile but difficult to work and conserve because of the steep slopes that range from 30 to 40 percent. Surface drainage is rapid, and internal drainage is moderate. This phase is not suited physically to tilled crops, but it is fairly well suited to pasture.

Although this phase is in all parts of the area that are underlain by dolomite or dolomitic limestone, the largest proportionate acreage is on Copper Ridge. Most of the soil is in extensive areas on steep slopes along the small streams that dissect the cherty ridge area. It is associated with Bolton and Fullerton soils and, to a less extent, with those of the Clarksville series.

The virgin profile of this phase is similar to that of Claiborne silt loam, hilly phase, but the various layers may be somewhat thinner. Where this phase is cleared, it has lost more of the surface soil through erosion than have others of the series. A moderate quantity of angular chert fragments is on and in the soil. Sandy cherty dolomite is at a depth of 20 feet or more in most places, but it may outcrop on the more severely eroded areas near the foot of some of the steeper slopes.

The soil is strongly acid and is relatively low in organic matter because the original supply has been lost or dissipated through erosion and cropping. In some places the upper part of the subsoil may be mixed with the remaining original surface soil, but good tilth is generally easy to maintain. Moisture conditions are less favorable than in other Claiborne soils because much water is lost through surface runoff.

Included in this mapping unit are variations resulting from differences in degree of accelerated erosion and in quality of chert. Where the soil has remained in forest, the surface layer is about 10 inches thick; but in cleared areas that have been used for crops nearly all of the original surface soil may be gone. This condition prevails over possibly a fourth of the phase, and where it occurs, tilth conditions are only fair and the loss of water through runoff is greatly increased. About a third of the soil has enough chert on the surface

and in the profile to interfere materially with tillage. Cherty areas are indicated on the map by chert symbols. In some places the boundary between this phase and some of the Bolton or Fullerton soils is not distinct, and small areas belonging to either of those series may be included with this soil in mapping.

Present use and management.—Claiborne silt loam, steep phase, is one of the more productive soils of the cherty ridges; and because it is associated with broad areas of unproductive soils, it is used for purposes for which it is not well suited physically. Furthermore, management practices designed to conserve the soil are not generally used. About 25 percent of the soil has never been cleared. The remaining 75 percent has been cleared and used for agricultural purposes at some time, but about a third of this has been abandoned to second-growth forests, mainly shortleaf pine.

The cleared areas are used for corn, hay, and pasture. In many places corn is grown for 2 or 3 years in succession, and the soil is then allowed to remain idle for several years. During the years of idleness, broomsedge, sassafras, and blackberries become established, and these are removed by burning and grubbing when the soil is again needed for crops. Some farmers use the idle fields for pasture. Lespedeza is the most common hay crop, but redtop and timothy are grown in a few places.

Small quantities of 0-10-4 fertilizer are used on corn, but hay crops are not fertilized. Little of the soil is ever limed. Tillage is roughly on the contour from necessity, but no other special practices for control of runoff and prevention of erosion are used.

Management requirements.—The physical properties of Claiborne silt loam, steep phase, are such that it is suited chiefly to pasture. Supplying amendments and conservation of moisture are the chief management requirements. Alfalfa, red clover, bluegrass, and white clover are best suited to the soil; but lespedeza, redtop, timothy, orchard grass, and Bermuda grass may also be used.

Legumes and bluegrass require fairly heavy applications of phosphorus, some potash, and at periodic intervals, moderate quantities of lime. Both crops are effective in binding the soil mass, in increasing humus content, in improving moisture-absorbing properties; and thereby, in controlling runoff and preventing erosion. Grazing should be carefully regulated, especially during periods of adverse moisture conditions, to prevent damage to stands of pasture. In many places it may be necessary to clip pastures at intervals to destroy weeds, but if grazing is properly managed, this practice may not be needed. Gullies can be stabilized by check dams. It may be advisable to reforest some of the most severely eroded areas. Before forest plantings can be successfully established, gullies should be brought under control. Moderate applications of phosphorus will assist in obtaining good stands of trees, especially of black locust.

Clarksville cherty silt loam, hilly phase.—Like the Clarksville cherty silt loam, rolling phase, this phase has a gray surface soil and a yellow subsoil. It is on steeper slopes, however, and is less fertile, more strongly acid, and less favorable in moisture conditions. It is poorly suited to crops, but under good management is fair pasture land. The soil has developed from material weathered from cherty dolomitic limestone under a mixed forest of post, blackjack, and red oaks, hickory,

dogwood, blackgum, and sourwood. Slopes range from 12 to 25 percent. Both internal and external drainage are rapid.

The soil occurs in all of the cherty ridge parts of the area in association with other Clarksville soils and the cherty Fullerton soils. It is chiefly in small- or medium-sized areas on the upper ridge slopes, but there are several broad areas of large extent.

The profile of this soil is similar to that of the rolling phase; but the various layers may be somewhat thinner everywhere, and where cleared, more of the original surface soil is missing. A profile description follows:

0 to 8 inches, light-gray loose floury cherty silt loam.

8 to 30 inches, yellow or brownish-yellow firm cherty silty clay loam.

30 inches+, reddish-yellow cherty clay.

Large cherty boulders are on the surface in many places, and by volume angular cherty fragments constitute half or more of the subsoil. Cherty dolomite bedrock is at depths of 20 feet or more in most places.

Where this phase is cleared, most of the fine soil material of the original surface layer is missing, and the surface soil is now a mixture of angular chert fragments and upper subsoil material. Tillage is difficult because of the large quantity of chert on the surface and throughout the profile. The soil is strongly to very strongly acid and very low in organic matter and mineral plant nutrients. Moisture conditions for plant growth are poor because of rapid runoff, low moisture-absorbing properties, and rapid percolation of water through the soil.

The most extensive variation in the soil is that of color in the lower subsoil. In areas of small or moderate extent the lower subsoil is in many places yellowish red or light red like that of Fullerton soils. Small areas of cherty Fullerton soils are included in this mapping separation either because they are too small to delineate on the map or because the boundary between the soils is not sharp. About 175 acres near Powell River in the vicinity of Flat Hollow is characterized by a sandy surface layer and by sandstone fragments on the surface. In areas of this variation, the subsoil is light yellow.

Present use and management.—Use of Clarksville cherty silt loam hilly phase, is determined largely by the immediate needs of land-owners or operators rather than by the physical use suitability of the soil. An estimated 70 percent of the soil is in forest. On the cleared land, corn, hay, and pasture are the chief crops, but small acreages of tobacco and other crops are grown in some places. As with other cherty ridge soils, management is at a low level. Corn is grown for 1 or 2 years and followed by hay or several years of idleness. Lespedeza is the chief hay crop, but pastures are mainly of broomsedge and other wild grasses.

Small quantities of fertilizer are used on corn and fairly large quantities on tobacco, but hay crops are not ordinarily fertilized. Little of the soil is ever limed. Contour tillage is practiced in many places, but this is by no means universal, and no other special devices for controlling runoff and preventing erosion are used.

Under prevailing management practices corn yields about 13 bushels an acre; burley tobacco, 500 pounds; and lespedeza or mixed hay, 0.4 ton.

Where the soil is used for forest, no special methods of management are practiced. The forest is not protected from fire or grazing. Selec-

tive cutting is not practiced, and no attempt is made to improve the quality or the yield of timber or to control disease or insect pests. Reforestation is ordinarily by natural reproduction.

Management requirements.—Because of low natural fertility, strong acidity, strong slopes, poor moisture conditions, and chertiness, Clarksville cherty silt loam, hilly phase, is not well suited to crops; but under careful management, it will produce fair pasture. Pasture management requirements are similar to those for comparable phases of Fullerton soils and consist chiefly of the proper choice of pasture mixtures, correct use of soil amendments, and proper control of grazing.

Bluegrass and white clover are suited to the soil. Orchard grass, reedtop, hop clover, lespedeza, and Bermuda grass can be expected to do well. Lime and phosphorus are needed, and relatively small applications at rather frequent intervals are preferable to large ones at long intervals. Potash is possibly needed. Nitrogen is useful in establishing good stands of pasture, but its continued use is not necessary where legumes are included in the mixture. Lespedeza and Bermuda grass can be grown with only small quantities of amendments under relatively poor soil conditions. These plants yield pastures of lower quality, but they may improve soil conditions, if properly managed, and then better stands can be obtained.

Grazing should be carefully controlled during droughts to prevent injury to pasture stands. Proper grazing is effective in keeping down weeds, but clipping once or twice a year may be necessary in some places. Gullies can be stabilized by check dams.

As much of the soil is distant from flowing streams or springs, it is necessary to provide water for grazing livestock. Ponds or reservoirs for collecting and storing rainfall are useful in some places; in others it is more practical to pipe water from springs or cisterns. There may be no practical method of obtaining water in areas such as those that are extremely cherty or severely eroded, and they are best used for forest. Some needed forestry practices are planting of suitable species of trees, protection from grazing and fires, removal of weed trees, and selective cutting in established forests.

Clarksville cherty silt loam, rolling phase.—Although this phase resembles the Fullerton soils in having a gray surface soil, it differs in having a yellow rather than a red subsoil. It is low in fertility, strongly acid, and cherty and is physically fair cropland. The soil is on the crests of ridges underlain by cherty dolomite or dolomitic limestone and was developed under a mixed hardwood forest of post, blackjack, and red oaks, hickory, dogwood, blackgum, and sourwood. Slopes range from 5 to 12 percent. Surface drainage is moderate, and internal drainage is rapid.

This phase is widely distributed over the cherty ridge area, but the largest acreage is on the crests of high steep ridges along the Powell River. The long narrow strips are associated chiefly with other Clarksville soils and cherty Fullerton soils.

The following describes a representative profile :

0 to 10 inches, loose floury light-gray cherty silt loam.

10 to 36 inches, yellow or brownish-yellow cherty silty clay loam.

36 inches +, yellow or reddish-yellow clay mottled with red, gray, and brown.

Angular chert fragments from 1 to 6 inches in diameter make up more than half the volume of the lower layers. Cherty dolomite bedrock is at depths of 20 feet or more.

In many cleared areas most of the finer soil material is missing, and the surface layer is chiefly a mass of angular chert fragments. Under forest the content of humus is low, and in cleared areas it has been almost completely dissipated through cropping and erosion. The soil is everywhere very strongly acid. It is difficult to work because of the large quantity of chert on and in the soil. Moisture moves through the soil rapidly, and the water-holding capacity is relatively low because of the large quantity of coarse material.

The chief variations in this phase are due to degree of erosion and the amount of chert on the surface and in the soil. In many places the lower subsoil is red or yellowish-red instead of dominantly yellow. Small areas of Fullerton soils are included either because they are too small to delineate on the map or because the boundary between the soils is not sharp. Small areas of soil having considerable sand on the surface and throughout the profile are also included.

Present use and management.—The use of Clarksville cherty silt loam, rolling phase, is fairly well adjusted to its physical properties, but management practices are not designed to improve the soil or to compensate for its deficiencies. Nearly all of the soil has been cleared, but some has been abandoned because of low productivity, and about 25 percent is now in forest. An estimated 25 percent of the cleared land is used for corn, 35 percent for hay and pasture, and 10 percent for other field crops. Most of the remaining 30 percent is idle land, but small acreages are used for tobacco, vegetables, and small grains.

General management practices are much like those used on comparable phases of Fullerton soils. Crops are not rotated. Corn may be grown for 1 or 2 years, and then broomsedge and other wild grasses and brush become established. Fields so managed remain idle for the most part, but some of them are used for pasture or hay. When they are again needed for corn they are cleared by burning. Lespedeza, timothy, and redtop are the chief hay crops, although a small amount of red clover is grown following burley tobacco.

Small quantities of fertilizer are used on corn, but none is ordinarily applied to hay or pasture. Tobacco receives barnyard manure where available, and, in addition moderate to large quantities of commercial fertilizer in most places. Little of the soil is ever limed. No special practices for control of runoff and prevention of erosion are ordinarily used.

Under common management corn yields about 15 bushels an acre; wheat, 9 bushels; burley tobacco, 700 pounds; and lespedeza or mixed hay, 0.5 ton. Many farmers state that the yields of tobacco are low, but the quality is generally better than that obtained on more productive soils.

Management requirements.—Like other cherty ridge soils, Clarksville cherty silt loam, rolling phase, is somewhat exacting in management requirements. Those described for Fullerton cherty silt loam, rolling phase, are applicable. Under good management corn yields 25 bushels an acre; wheat, 13 bushels; lespedeza, 0.9 ton; and burley tobacco, 900 pounds. In some of the more severely eroded or most cherty

areas, conditions are so unfavorable that the soil is not suited either to crops or pasture and is best used for forest.

Clarksville cherty silt loam, steep phase.—Like other Clarksville soils, this phase has a gray surface soil and a yellow subsoil. It is low in fertility and poor in moisture conditions. The soil is on the steep slopes of ridges underlain by cherty dolomite or dolomitic limestone and was developed under a hardwood forest of post, blackjack and red oaks, hickory, blackgum, sourwood, and dogwood. Slopes range from 25 to 50 percent, but in most areas are 30 to 40 percent. Surface drainage is very rapid and internal drainage rapid.

The phase occurs in all cherty ridge areas, chiefly in association with other Clarksville soils and those of the Fullerton series. The largest acreage is on ridges along the Powell River and its tributaries. Long, moderately broad strips occur on the steep slopes along these streams.

A profile description follows:

0 to 8 inches, light-gray cherty silt loam.

8 to 24 inches, yellow or brownish-yellow cherty silty clay loam.

24 inches +, reddish-yellow cherty clay.

Bedrock is at a depth of 20 feet or more in most places, but it may outcrop on the surface, especially on lower slopes. Large chert boulders are on the surface in many places.

The soil is very strongly acid in most places, and the content of organic matter is very low. Moisture conditions are poor because of the loss of water through rapid runoff and the poor water-retaining properties of the soil. Forest growth is probably slower than on any other cherty ridge soil on comparable slopes. Where the land is cleared, most of the original surface soil material has been lost through accelerated erosion, and the surface layer is now a mixture of the upper subsoil material and angular chert fragments. In such places the content of organic matter and plant nutrients is very low. Moisture conditions for plant growth are very poor, and tillage is difficult because of chertiness and steep slopes.

As with the hilly phase, the most extensive variation included in this phase is due to differences in the color of the lower subsoil. Many small- or medium-size areas have a yellowish-red or red lower subsoil similar to that of the Fullerton soils. Small areas of Fullerton cherty silt loam, steep phase, are included in this one either because they are too small to delineate on the soil map or because the boundary between the soils is not sharp. Some areas of sandy soil are also included.

Present use and management.—As with the hilly phase, the use of Clarksville cherty silt loam, steep phase, is variable and is determined largely by the needs of the landowners and operators rather than by the physical use suitability of the soil. An estimated 75 percent or more of the soil is now in forest. The cleared land is used for corn, hay, and pasture, but part of it is idle or abandoned. Good management methods are not practiced. Corn is grown for 1 or 2 years, and then the land is planted to lespedeza or left fallow. Pastures are chiefly broomsedge and other wild grasses. Small quantities of commercial fertilizer are used on corn, but otherwise the soil ordinarily receives no amendments. Contour tillage is practiced from necessity, but no other special methods for preventing erosion or conserving moisture are used. Yields of crops are very low.

Where the soil is used for forests, no special methods of management are practiced, and no special attempts are made to prevent fires and grazing or to control insect pests and diseases. Selective cutting is not practiced. Timber yields are small and of poor quality, and they will become progressively smaller and poorer under present forest management.

Management requirements.—Clarksville cherty silt loam, steep phase, is not suited to crops or pasture, because it is low in fertility, strongly acid, cherty, steeply sloping, and poor in moisture conditions. It is best used for forest, although trees grow more slowly and are of lower quality than on many other soils. Areas now in forest should remain so, and cleared tracts should be reforested. The more severely eroded cleared areas may require some special soil preparation before satisfactory stands of trees can be obtained. Gullies should be stabilized, and certain species of trees may benefit from applications of phosphorus. Young forest plantings should be carefully protected from fires and grazing, and in some places simple practices for controlling rodents and insect pests may be useful. Undesirable and mature trees should be removed from established forests to allow harvesting a timber crop at regular intervals.

Clarksville loam, rolling phase.—This soil resembles Fullerton loam, rolling phase, in some respects but has a lighter colored surface soil and a yellow rather than a red subsoil. It is low to medium in fertility, easy to work, fairly easy to conserve, and fair to good as cropland. The soil is on the crests of cherty ridges underlain by sandy dolomite or dolomitic limestone and was developed under a mixed forest of oaks, hickory, blackgum, sourwood, and dogwood. Slopes range from 5 to 12 percent. Both surface and internal drainage are good. This phase is in small areas on the ridge tops on the northwestern side of the Powell River and is associated chiefly with Fullerton loam, rolling phase, and other Clarksville and Fullerton loams.

Following is a profile description:

0 to 8 inches, yellowish-gray loose loam.

8 to 32 inches, light brownish-yellow or yellow friable light silty clay loam.

32 inches +, yellowish-brown to reddish-yellow moderately friable light silty clay mottled with gray, brown, red, and yellow.

Small pieces of chert and sandstone are on the surface and in the soil. Bedrock is at a depth of 20 feet or more.

The soil is low in organic matter and strongly acid. Roots, air, and soil moisture move easily through the soil. It may be somewhat droughty because of its open porous nature and consequent low water-retaining properties. Good tilth is maintained with ease, and the soil can be worked over a wide range of moisture conditions.

Present use and management.—Clarksville loam, rolling phase, is used and managed in a manner fairly well adjusted to its physical properties. Practically all of it is cleared and cultivated. It is used for growing all of the common field crops. Management practices are variable but generally similar to those used on other cherty ridge soils. The soil is associated with Fullerton loam, rolling phase, in many places, and management practices are similar. Under common practices of management corn yields about 18 bushels an acre; wheat, 9 bushels; burley tobacco, 600 pounds; and lespedeza hay, 0.6 ton.

Management requirements.—The requirements for good management of Clarksville loam, rolling phase, are very similar to those described for Fullerton loam, rolling phase.

Colbert silt loam, rolling deep phase.—This soil is on the uplands of limestone valleys and is developed from the residuum of clayey or shaly limestone. It differs from Colbert silty clay loam, eroded rolling phase, chiefly in being deeper over bedrock and in having a lighter textured surface soil and a deeper less plastic subsoil. It is more productive of field crops than the eroded rolling phase and is fair cropland. Slopes range from 5 to 8 percent. External drainage is moderate and internal drainage slow. The greatest acreage is in the vicinity of Maynardville in Raccoon Valley.

Following is a profile description :

0 to 8 inches, dark-gray to light-brown friable silt loam.

8 to 24 inches, brownish-yellow moderately to strongly plastic silty clay with a well-developed medium blocky structure.

24 inches +, yellow tenacious clay mottled with gray and rust brown.

The soil is medium to strongly acid. The surface layer contains a moderate quantity of organic matter that soon disappears under cultivation. Both the surface soil and subsoil are moderately absorptive and retentive of moisture, but the dense substratum hinders free movement of moisture. In many places much of the original surface soil has been lost through accelerated erosion and the rest has been mixed with the subsoil. These eroded places have a grayish-yellow silty clay loam surface layer.

Present use and management.—Colbert silt loam, rolling deep phase, is used and managed in much the same manner as Talbott silt loam, undulating phase. All the soil has been cleared and is now cultivated. An estimated 20 percent is in pasture, 30 percent in forage crops, 25 percent in corn, 15 percent in small grain, and 10 percent in other crops or idle. Systematic rotation of crops is not commonly practiced, and many farmers grow corn several years in succession and then leave the land idle a number of years. Others alternate corn and hay according to their farm needs.

Corn and small grains receive 100 to 200 pounds of 0-10-4 or 0-20-0 fertilizer an acre on some farms. Hay and pasture ordinarily do not receive any fertilizer. The small quantity of lime used is generally applied to hay crops or pasture. Mechanical means of runoff control are not commonly used, but tillage is generally on the contour. Under common management practices corn yields 18 bushels an acre; wheat, 10 bushels; lespedeza, 0.8 ton; and alfalfa, 1.8 tons.

Management requirements.—Colbert silt loam, rolling deep phase, is exacting in its requirements for good management. Control of runoff and erosion, improvement of moisture conditions for plant growth, and increasing the supplies of humus, lime, and mineral plant nutrients are required. Wherever practical the soil is probably best used for hay and pasture crops, but with careful management it can be conserved under a rotation that includes intertilled crops once in 6 years. Corn followed by small grain seeded to a pasture or hay crop makes a desirable rotation. Alfalfa, red clover, and sod-forming grasses, especially bluegrass, are effective in increasing humus and nitrogen content, improving tilth, increasing moisture-absorbing qualities, and preventing

erosion. It is especially important that cover crops be kept on this soil during fall and winter.

Liberal quantities of potash and phosphorus are necessary for good growth of legumes and grasses—the plants essential in maintaining or improving the productivity of this soil. Lime is required in moderate quantities. Although runoff should be controlled largely by proper choice and rotation of crops and the use of adequate amendments, other practices are required in most places. Strip cropping may be helpful on the longer slopes, and contour tillage is necessary everywhere.

Colbert silty clay loam, eroded rolling phase.—This soil is on rolling or undulating limestone-valley uplands in association with soils of the Talbott series, and with both the Smooth and Rolling stony lands (Talbott soil material). It has a very heavy compact subsoil and is underlain by clayey or shaly limestone. The soil is difficult to work and conserve and low to medium in fertility. Although not suited to growing crops, it is fairly well suited to pasture. On uncleared areas there is a mixed forest, including redcedar, oak, blackgum, and sweetgum, and apparently the soil was developed under a similar forest cover. Slopes range from 2 to about 15 percent, but most of them are between 5 and 10 percent. Surface drainage is moderate, but internal drainage is slow because of the impermeable subsoil and the shallow depth to bedrock. Small areas of this phase are found throughout all the limestone valleys of the county.

Following is a profile description :

- 0 to 5 inches, gray or grayish-yellow slightly plastic silty clay loam.
- 5 to 24 inches, yellow or brownish-yellow very strongly plastic tenacious heavy silty clay spotted with brown and red in the lower part.
- 24 inches +, tenacious clay highly mottled with yellow, brown, and red.

Clayey limestone is at a depth of about 2 feet, and in some places it contains thin shaly layers. The rock floor is uneven, and on the surface outcrops and ledges of limestone are common. Fragments and slabs of limestone rock are on the surface in many places.

In most places the surface soil is a gray or dark-gray heavy silty clay loam 4 to 5 inches thick, but where erosion has been serious, this layer may be missing. The surface soil is sticky and plastic when wet, moderately friable and crumbly when moist, and very strongly acid. In some places the upper inch or two of the surface layer is fairly high in organic matter, but in most places this part has been lost as a result of accelerated erosion. Moisture moves very slowly through the subsoil, and most of the water that falls on the land is therefore lost in runoff.

Good tilth is difficult to maintain, and the range of moisture conditions favorable for tillage is narrow. If the soil is plowed or cultivated when too wet, it becomes hard and cloddy, and tillage is practically impossible when it is dry.

Included in mapping are variations due to degree of erosion and to differences in color of the surface soil and subsoil. On a few areas the original surface soil has been removed by erosion and the upper part of the original subsoil is now at the surface.

Present use and management.—For Colbert silty clay loam, eroded rolling phase, use and management are variable, depending largely upon the use and management of the associated Talbott soils or the Smooth and Rolling stony lands (Talbott soil material). Practi-

cally all of this soil is cleared. An estimated 25 percent is used for growing corn, 50 percent for hay and pasture, and 25 percent is in other crops or idle. Amendments may be used in small quantities on corn, but pastures generally are not treated with either lime or fertilizer. Special practices for control of runoff and erosion are not used. Corn yields are very low under common management practices. On the average, about 40 cow-acre-days of grazing can be expected.

Management requirements.—Because few areas of Colbert silty clay loam, eroded rolling phase, are large enough to be used alone, its management is determined largely by the requirements of the associated areas of either Talbott soils or Smooth and Rolling stony lands (Talbott soil material). In general, the soil cannot be conserved where used for tilled crops. It requires pasture management similar to that for Talbott silty clay loam, eroded hilly phase, and where its use for tilled crops is necessary, management requirements for crops will be similar.

Cumberland silt loam.—This red fertile soil is developed on old high stream terraces. The parent materials have washed predominantly from uplands underlain by limestone but are mixed with small quantities of material from shale and sandstone. The surface is undulating to rolling with slopes of 2 to 12 percent. Both surface and internal drainage are moderate. The native vegetation is principally deciduous hardwoods, and chief species are oak, hickory, chestnut, tuliptree, and maple. Nearly all of the forest has been entirely removed or cut over. Most of this soil is on high terraces near the junction of the Powell and the Clinch Rivers.

Following is a profile description:

- 0 to 12 inches, brown to dark grayish-brown friable silt loam.
- 12 to 48 inches, reddish-brown moderately friable to firm silty clay loam with a fine moderately well-developed nut structure.
- 48 inches +, red to yellowish-red plastic silty clay spotted with yellow and gray.

Very small dark-brown to nearly black soft concretions are common to the subsoil and substratum. The terrace deposit is variable in thickness, but it is usually more than 3 feet thick and in a few places as much as 15 feet. It is generally underlain by limestone or by shale containing some limy material. The entire profile is medium to strongly acid.

The fertility of the soil is high, and its permeability to both roots and water is moderately good, although runoff is greater than on some soils because of impaired percolation. The thickness of the surface layer varies according to degree of erosion. In some places this layer is less than 6 inches thick, and in others some subsoil material has been mixed with it by tillage.

Present use and management.—Practically all of Cumberland silt loam has been cleared and is now being used for crops and pasture. About 40 percent is used for corn, 35 percent for hay, 10 percent for tobacco, and 15 percent for other crops. Systematic rotation of crops is not commonly practiced. Tobacco is almost always fertilized heavily and much of it receives manure. Alfalfa is invariably limed and usually fertilized with manure or phosphate fertilizer. Corn and small grains receive little fertilizer of any kind. Under common

management, corn yields about 40 bushels an acre; wheat, 18 bushels; burley tobacco, 1,500 pounds; alfalfa, 3.6 tons; and lespedeza, 1.3.

Management requirements.—Cumberland silt loam is one of the most fertile soils of the area. The smooth surface, good internal drainage, and friability of the surface layer make it easy to work and conserve. Properly managed, it can be used in a relatively short rotation and is suited to a wide variety of crops. A rotation consisting of 1 year in corn or tobacco, 1 year in small grain, and 2 years in a legume hay crop should be well suited to this soil.

Although the soil is naturally fertile, a good response to moderately heavy applications of phosphorus, lime, and manure can be expected. Some attention must be given to the control of runoff if the soil is to be maintained in a highly productive state. Close-growing grain, hay, and winter cover crops, and, on the more sloping parts, contour tillage are effective controls. Under good management corn yields 50 bushels an acre; wheat, 28 bushels; burley tobacco, 1,800 pounds; alfalfa, 4.2 tons; and lespedeza, 1.7 tons.

Dewey silt loam, undulating phase.—Although this is probably the most productive soil of the uplands, it is relatively unimportant because of small extent. It is less eroded, more fertile, and less cherty than any other Dewey soils; and it is physically good to excellent cropland. The soil is on well-drained undulating uplands underlain by high-grade limestone and was developed under a mixed deciduous forest of oak, hickory, maple, walnut, and beech. The content of organic matter is high as compared with that of other soils of the uplands, including other members of the Dewey series. Good tilth is easily maintained. Air and water circulate freely, but the soil is retentive of moisture. Slopes range from 2 to 5 percent.

This phase occupies small areas in Powell and Big Valleys. It is on the crests of low hills, and Dewey silty clay loam, eroded rolling phase, is on adjoining slopes.

A profile description follows:

0 to 10 inches, grayish-brown or brown friable heavy silt loam.

10 to 46 inches, red or brownish-red slightly plastic silty clay with a well-developed nut structure.

46 inches +, red silty clay mottled with yellow, gray, and brown.

The surface layer is free of stones and chert, but the lower layers contain some angular chert. The soil is medium acid in most places.

Present use and management.—Use and management of Dewey silt loam, undulating phase, are moderately well adjusted to the physical properties of the soil, but increased yields can be obtained by improved farming practices. All the soil is cleared and is used for corn, tobacco, wheat, hay, and vegetables. Some farmers use a rotation in which a row crop is followed by small grain and hay, but many small areas are used for growing tobacco several years in succession. Barnyard manure and heavy applications of commercial fertilizer are used under tobacco. Crimson clover, rye, or some other cover crop is planted after the tobacco is harvested.

Many small areas are used continuously as home vegetable gardens and these receive heavy applications of both barnyard manure and commercial fertilizer. Some areas are included in fields with Dewey silty clay loam, eroded rolling phase, and are used and managed in the same manner as that soil.

Under common management corn yields 40 bushels an acre; wheat, 19 bushels; burley tobacco, 1,500 pounds; alfalfa, 3.6 tons; and lespezea 1.3 tons.

Management requirements.—Supplying mineral plant nutrients and lime and the maintenance of humus are the chief requirements for good management of Dewey silt loam, undulating phase, but simple practices for the control of runoff are also needed. The soil is suited to moderately intensive use, and apparently can be conserved under a rotation that includes a row crop once in 3 years. Where tobacco, vegetables, or such row crops are grown several successive years, winter cover crops including crimson clover, rye, and winter oats are effective in maintaining the nitrogen supply and preventing erosion.

This soil is acid, and moderate applications of lime at rather long intervals are necessary to obtain good yields of legumes. Lime should not be applied immediately before the planting of tobacco, potatoes, and vegetable crops. All crops require moderate to heavy applications of mineral fertilizer containing phosphorus and possibly potash. Barnyard manure is valuable as a source of humus, nitrogen, and potassium. Contour tillage is advisable, but mechanical devices for the control of runoff are not ordinarily necessary.

Dewey silty clay loam, eroded hilly phase.—This phase differs from Dewey silty clay loam, eroded rolling phase, chiefly in having steeper slopes (12 to 25 percent). It is more severely eroded than that phase and consequently less fertile, less easily worked, and less easily conserved. Physically, it is poor to fair cropland. The soil is on well-drained uplands underlain by high-grade or slightly cherty limestone and was developed under a deciduous forest that included oak, hickory, maple, and black walnut. Surface drainage is rapid and internal drainage moderate. This phase is associated with other Dewey soils and those of the Talbott series in the limestone valleys. The areas are small to medium in size and irregularly shaped.

Following is a profile description :

- 0 to 6 inches, grayish-brown or brown moderately friable silty clay loam.
- 6 to 36 inches, red or brownish-red slightly plastic silty clay with a moderately well-developed nut structure.
- 36 inches +, sticky plastic red silty clay mottled with olive, yellow, and brown.

A moderate quantity of chert fragments is on the surface, and there are fragments of limestone rock in some places. Bedrock crops out in a few places where the soil is most severely eroded, but in most places it is at a depth of 10 feet or more.

The soil is generally strongly acid. The content of organic matter is relatively low as a result of loss through erosion and cropping. Good tilth is moderately difficult to maintain because the plow layer in most places includes part of the heavy subsoil, which is sticky and plastic when wet and hard and intractable when dry.

Present use and management.—Dewey silty clay loam, eroded hilly phase, is not well adapted to present practices of use and management. Practically all of the soil has been cleared and cultivated, but an estimated 25 percent is now idle. About 50 percent is used for field crops and 25 percent for pasture. Management practices vary considerably on different farms. A few farmers use a rotation of corn,

small grain, and hay, but no definite cropping system is in general use. Corn is grown for several years in succession and then followed by lespedeza hay or poor pasture.

About 100 pounds of 0-10-4, 0-16-0, or 0-20-0 commercial fertilizer an acre is applied to the corn crop, and barnyard manure also is used where available. Practically no fertilizer is used on other crops. Only a small acreage of this soil receives periodic lime applications. Specific practices for the conservation of moisture and control of erosion are not generally used; but tillage is on the contour in most places, largely from necessity.

Under common management corn yields about 25 bushels an acre; wheat, 14 bushels; tobacco, 1,000 pounds; and lespedeza hay, 0.9 ton. Where lime is used in addition to other common management practices, alfalfa yields 2.4 tons and red clover 1 ton.

Management requirements.—Good management of Dewey silty clay loam, eroded hilly phase, requires chiefly the prevention of further erosion, the improvement of the physical condition of the surface soil, and the betterment of moisture conditions for crops. Practices that will increase supplies of humus and nitrogen and furnish phosphorus and probably potash are also required. Sod-forming grasses and legumes, as alfalfa and red clover, are effective in controlling runoff and in increasing the content of organic matter and nitrogen, and they should be grown during much of each rotation. Corn for 1 year followed by wheat and alfalfa is a desirable rotation.

Barnyard manure supplies nitrogen, improves tilth and moisture conditions for crops, and furnishes some potassium; but additional nitrogen from commercial fertilizer is possibly needed. Moderate applications of lime at fairly long intervals and liberal applications of phosphorus are necessary for good growth of legumes, and they will increase yields of other crops.

Although runoff should be controlled largely by proper choice and rotation of crops and judicious use of amendments, other control measures may be necessary. Contour tillage should be practiced. Where row crops are grown, strip cropping may be practicable on the longer slopes.

Under good management corn yields about 35 bushels an acre; wheat, 18 bushels; burley tobacco, 1,400 pounds; and lespedeza 1.3 tons.

Dewey silty clay loam, eroded rolling phase.—This is a relatively fertile moderately eroded acid soil with a brownish surface layer and a red subsoil. It is fair to good cropland. Like other soils of the Dewey series, it is on well-drained uplands underlain by high-grade or slightly cherty limestone. It was developed under a deciduous forest of oak, hickory, black walnut, and maple. Slopes range from 5 to 15 percent but are usually between 8 and 10 percent.

The soil is in most of the limestone valleys in association with other members of the Dewey series, with soils of the Talbott and Caylor series, and with Smooth stony land (Talbott soil material). It is also in the vicinity of Leadmine Bend Creek and near the junction of the Powell and the Clinch Rivers, and in these areas it is associated with soils of the Fullerton series.

A profile description follows:

0 to 8 inches, grayish-brown or brown moderately friable silty clay loam.
8 to 40 inches, yellowish-red, red, or brownish-red slightly plastic silty clay with a moderately well-developed nut structure; small dark concretions are common in the lower part of the layer.

40 inches +, sticky, plastic red silty clay faintly streaked and mottled with yellow, brown, olive, and gray.

A few fine chert fragments are on the surface and in the soil. Depth to bedrock ranges from 20 to 30 feet.

The soil is medium to strongly acid and is moderately low in organic matter as a result of intensive cropping and loss of material through accelerated erosion. Where little of the original material has been lost, the soil is easily maintained in good tilth. In many areas, however, enough material has been lost to permit mixing of the heavier subsoil with the remaining part of the original surface soil, and in these the plow layer is sticky and plastic when wet and hard and intractable when dry. The surface soil on the more severely eroded areas bakes and cracks during droughts.

Present use and management.—For Dewey silty clay loam, eroded rolling phase, use and management vary from farm to farm, but usually they are only fairly well adjusted to the physical character of the soil. Practically all the land is cleared and cultivated. An estimated 35 percent is used for hay, and the rest is planted to other crops, including corn, wheat, tobacco, and pasture. The better farmers commonly use a rotation of corn or tobacco, small grain, and hay. In many places, however, no definite rotation is followed; and corn or tobacco may be grown for several years in succession and then followed by small grain, lespedeza hay, or volunteer pasture.

Corn is usually fertilized with about 100 pounds of 0-10-4, or the equivalent, an acre and with barnyard manure where available. Heavier applications of both commercial fertilizer and manure are used for tobacco. Neither is commonly used for hay or pasture. Small grains usually are not fertilized or are fertilized only lightly. Probably less than a fourth of this soil is limed periodically. Engineering methods for controlling runoff are not commonly used, but tillage is usually roughly on the contour.

Under the common management practiced corn yields about 30 bushels an acre; wheat, 14 bushels; burley tobacco, 1,100 pounds; and lespedeza hay, 1.1 tons. On the farms where lime is used for legumes, alfalfa yields 2.8 tons an acre.

Management requirements.—Good management of Dewey silty clay loam, eroded rolling phase, requires practices similar to those for the eroded hilly phase. Runoff can be controlled and organic matter and nitrogen contents can be increased by keeping alfalfa, red clover, or other legumes on the soil for much of the rotation. Clean-cultivated row crops should not be grown more than once in 4 years. Small grain for 1 year followed by a legume for hay or pasture would complete a desirable rotation and maintain or increase the content of organic matter and nitrogen.

Lime should be applied at the rate of 2 to 3 tons an acre at rather long intervals, and liberal applications of phosphorus are necessary for good growth of legumes, the crops around which a rotation for soil improvement centers. Response to potassium also can be expected. Barnyard manure is especially beneficial as it supplies nitrogen and potassium and improves tilth and moisture relations. It is especially effective in obtaining stands of alfalfa. To control runoff, cultivation

should be on the contour, and strip cropping should be considered in favorable locations. If the system of farming is such that it is not feasible to keep the soil in close-growing or sod-forming crops much of the time, terracing should be considered as a means of controlling runoff. Terraces must be properly constructed and well maintained to be effective.

Under good management corn yields 45 bushels an acre; wheat, 20 bushels; burley tobacco, 1,500 pounds; and lespedeza hay, 1.5 tons.

Dewey silty clay loam, eroded steep phase.—This moderately fertile, strongly acid, and rather severely eroded soil is on well-drained uplands underlain by high-grade or slightly cherty limestone. It was developed under a deciduous forest of oak, hickory, maple, black walnut, and possibly cedar. Surface drainage is very rapid and internal drainage moderate. The soil is associated with other phases of Dewey silty clay loam in the limestone valleys and occurs on short steep slopes having gradients of more than 25 percent.

Following is a profile description :

0 to 6 inches, grayish-brown or brown moderately friable silty clay loam.

6 to 30 inches, red or brownish-red slightly plastic silty clay.

30 inches +, red sticky plastic silty clay spotted with gray, yellow, and brown.

A moderate quantity of chert is on the surface and in the soil. There are outcrops of bedrock in some places, and loose fragments of limestone rock may be on the surface. Massive limestone bedrock is at a depth of about 10 feet.

The original surface soil is missing in most places, and the upper part of the original subsoil is now the plow soil. This phase is strongly acid and low in organic matter because of loss of material through erosion, but the supply of mineral plant nutrients is high in comparison with that of other soils on similar slopes. Good tilth is difficult to maintain in the plow layer because of heavy texture.

Present use and management.—In the past Dewey silty clay loam, eroded steep phase, was used for purposes for which it was not physically suited. Practically all of it has been cleared and used for growing tilled crops at some time, but much of it is now abandoned. Poor quality pasture is on some areas, but much of the soil has grown up in second-growth woodland, chiefly of Virginia pine.

Management requirements.—Although Dewey silty clay loam, eroded steep phase, is similar to the eroded rolling phase, its requirements for use and good management are markedly different because it has steeper slopes and is to a greater degree eroded. Apparently this soil cannot be conserved where used for tilled crops, and is best used for pasture or forest. Management requirements on pasture include practices for preventing further erosion, conserving moisture, increasing the content of nitrogen, and supplying lime, phosphorus, and potash.

Good stands of legumes and sod-forming grasses can be established by applying moderate quantities of lime and liberal quantities of phosphorus. These crops will be effective in increasing the humus content and the moisture-holding capacity of the soil, and thereby, in decreasing runoff. In addition, the root mat holds the soil in place and prevents loss of material through erosion.

The more seriously eroded areas are possibly best suited to forest. On such areas gullies should be controlled before trees are planted. Moderate applications of phosphate fertilizer are effective in obtaining a vigorous growth of young trees, especially black locust. Young forests should be carefully protected from fire and grazing.

Emory silt loam, undulating phase.—This fertile slightly acid brown soil of the colluvial lands is on foot slopes and benches along intermittent streams in the cherty ridges and in the limestone valleys. In most places it occupies the entire area of colluvial land on which it occurs, but in some places Greendale soils may be associated. It is excellent cropland. The parent materials are colluvium and local alluvium rolled and washed from adjoining uplands underlain by dolomite and limestone—uplands where the Bolton, Claiborne, and Dewey are the chief soils. The soil was developed under a hardwood forest. Slopes range from 2 to 8 percent, but most of the phase is nearly level to gently sloping. It is well drained both internally and externally.

This young soil does not have a well-developed profile and it varies from place to place according to the nature of the adjoining upland and the manner in which the soil material was deposited. Following is a profile description :

- 0 to 18 inches, grayish-brown to brown friable silt loam or heavy silt loam.
- 18 to 36 inches, brown or yellowish-brown friable heavy silt loam or silty clay loam.
- 36 inches +, yellowish-brown silt loam splotched with gray and yellow.

In some places there are a few angular chert fragments on the surface and in the soil. The depth to bedrock is highly variable and may range from 2 to 15 feet or more.

Compared with the upland soils of the county, this one is relatively high in humus and nitrogen. It is slightly to medium acid. The supplies of potash and phosphorus are higher than in the associated upland soils. Moisture conditions are favorable to plant growth, as the soil is permeable to moisture but has, nonetheless, a high moisture-holding capacity. Excellent tilth is easily maintained, and tillage operations can be accomplished with ease over a fairly wide range of moisture conditions.

Present use and management.—All of Emory silt loam, undulating phase, is cleared and cultivated. About 50 percent is used for corn, 20 percent for tobacco, and 20 percent for small grain. Most of the rest is used for hay and pasture, but small acreages of potatoes and other vegetables are raised. Lespedeza, red clover, and timothy are the chief hay crops. Present use and management are fairly well adjusted to the physical properties of the soil, but there are few places where productivity could not be increased by improved management.

A few of the better farmers use a rotation in which a row crop is followed by small grain seeded to hay. The hay is allowed to remain 1 or 2 years. In many places no systematic rotation is used, and tobacco or corn may be grown for several years in succession and then followed by small grain or hay. In contrast to the adjoining upland soils, practically none of this soil is idle during a crop season.

Little of the soil is ever limed. Most farmers fertilize tobacco with moderate to large quantities of complete fertilizer, and in many

places small applications are used on corn. Hay crops ordinarily receive no amendments. Tillage operations are carried out with greater care and more promptness than on adjoining upland soils, largely because this soil is more productive and more responsive to good management.

Under prevailing systems of management corn yields about 40 bushels an acre; wheat, 20 bushels; burley tobacco, 1,500 pounds; lespedeza, 1.5 tons; and alfalfa, 3.2 tons.

Management requirements.—Increased yields can be obtained economically on Emory silt loam, undulating phase, by proper choice and rotation of crops and the use of fertilizer and soil amendments. The soil is suited to intensive use, and if it is well managed, row crops can be grown in alternate years. A row crop should be followed by small grain, and crimson clover should be seeded early in fall after the small grain is harvested. The crimson clover forms a winter cover crop that can be turned under in spring as a green manure. The clover increases the humus content and the nitrogen supply, and thereby improves tilth, moisture conditions, and soil fertility.

Under the system just mentioned, nitrogen fertilizer should not be necessary on corn, but moderate to large quantities of phosphorus and potash should be applied. Where tobacco is grown, moderate or large quantities of complete fertilizer high in phosphorus and potash are needed. Small grains should also receive moderate quantities of similar fertilizer, but the potash content can be lower. Some of the soil probably needs lime, but much of it is nearly neutral in reaction. If lime is needed, moderate to heavy applications should be made at fairly long intervals.

The soil has no special problems of water control either in regard to drainage or prevention of erosion. Accelerated erosion, however, should be prevented on the adjoining upland slopes in order to protect this soil from deposits of heavy subsoil material.

Under good management corn yields about 60 bushels an acre; wheat, 28 bushels; burley tobacco, 1,800 pounds; lespedeza, 1.8 tons; and alfalfa, 4 tons.

Fullerton cherty loam, rolling phase.—This phase has gray light-textured surface soil and reddish subsoil. Because it is low in fertility and moderately difficult to work but fairly easy to conserve, this soil is rated as poor to fair cropland. It is on upland ridges underlain by cherty dolomite or dolomitic limestone containing thin layers of sandstone. It was developed under a mixed forest of oak, hickory, black-gum, sourwood, dogwood, and shortleaf pine. Slopes range from 5 to 12 percent. External drainage is moderate and internal drainage somewhat rapid.

The soil occupies irregularly shaped areas of small to medium size or occurs in long narrow strips on the crests of ridges. It is associated chiefly with other Fullerton loam soils, but in some places Claiborne or Bolton soils are on the adjoining slopes, especially those facing north and east.

The profile is similar to that of the rolling phase of Fullerton loam, although the surface soil is somewhat lighter in color and more sandy and contains a much larger quantity of chert fragments. A profile description follows:

0 to 10 inches, gray or light-gray loose cherty loam.

10 to 40 inches, yellowish-red moderately friable cherty sandy clay or sandy clay loam with a weakly developed nut structure.

40 inches +, red cherty clay mottled with gray, brown, and yellow.

Cherty dolomite bedrock containing thin layers of sandstone is at depths of 20 to 50 feet or more.

In some places nearly all the fine soil material has been lost through erosion, and the present surface layer is largely a mass of angular chert fragments. The content of organic matter is very low because the small original supply has been depleted by cropping and erosion. The soil is strongly or very strongly acid and permeable to moisture, air, and plant roots. It is low in water-holding capacity because of the large proportion of coarse materials, and crops are severely injured by prolonged droughts. Because of the large quantity of chert, workability is poor and cannot be materially improved by practical means.

The chief variations in this phase are due to differences in thickness and chertiness of the surface soil caused by erosion. Small areas of other Fullerton soils are included with this one because the boundaries are not clear or the change from this to another type or phase is gradual over a considerable distance. Areas of other soils are included because they are too small to delineate on the map.

Present use and management.—The use of Fullerton cherty loam, rolling phase, is fairly well adjusted to its physical properties; but management is at a low level, and almost no practices designed to improve the soil or to compensate for its deficiencies are employed. An estimated 25 percent is in forest. About 25 percent is used for growing corn, and some 30 percent is in hay and pasture. Most of the remaining 20 percent is idle land, but small areas are used for tobacco, small grains, fruits, and vegetables.

Systematic crop rotation is not practiced, and in most places the immediate needs of the farm owner or operator determine what crop will be grown in a particular field. Corn is grown for 1 or 2 years; after which the soil remains idle for several years. Weeds, broom-sedge, and brush, grow up during the rest period and these are removed by burning before another corn crop is planted. Some of these fields are used for pasture, but many of them are idle. Lespedeza is the chief hay crop, but some redtop and timothy also are grown. Except for the small quantities of fertilizer some farmers use on corn, no soil amendments are applied.

Under prevailing systems of management corn yields about 18 bushels an acre; burley tobacco, 700 pounds; lespedeza, 0.6 ton; and mixed hay, 0.8 ton.

Management requirements.—Where Fullerton cherty loam, rolling phase, is used for cropland, it has several special management requirements. These are chiefly the proper choice and rotation of crops and the use of lime and fertilizer, but some measures for conserving moisture and preventing erosion are necessary. The management practices described for Fullerton cherty silt loam, rolling phase, are applicable to this soil.

Some areas are so cherty and stony that they are suited to neither crops nor pasture. Such areas now in forest should remain in forest, and the cleared tracts should be reforested. Reforestation is accomplished with least effort and cost by natural reproduction from adjoining woodlands, but quicker results can be obtained by the systematic planting of suitable species of trees.

Fullerton cherty silt loam, hilly phase.—Like other Fullerton soils this phase has gray surface soil and red subsoil. It is moderately low in fertility, difficult to work, and moderately difficult to conserve. The soil is on slopes of ridges underlain by cherty dolomite and dolomitic limestone, and was developed under a mixed forest of oak, hickory, blackgum, sweetgum, dogwood, and possibly some shortleaf pine. Slopes range from 12 to 25 percent. Internal drainage is moderate, and external drainage is rapid. The soil occurs in irregularly shaped areas of medium or large size and is associated with other Fullerton soils and those of the Claiborne, Bolton, and Clarksville series. It is one of the most extensive soils in the area.

The profile is very similar to that of the rolling phase, but the thickness of the various soil layers may be somewhat less. Where the soil has been cleared, part of the original surface layer has been lost through erosion, and in many places the upper subsoil is turned by the plow and mixed with the remaining surface soil material. Under forest, the content of organic matter is relatively low, and on cleared land this small supply is rapidly dissipated through cropping and erosion. The soil is strongly acid everywhere. Where it is used for crops, good tilth is moderately difficult to maintain; and moisture conditions are only fair because water runs off the strong slopes and the present surface layer has a low absorptive capacity. Cherty dolomitic bedrock is at depths of 20 feet or more (pl. 1, *B*).

The chief variations in the soil are caused by accelerated erosion. In many places small areas of Clarksville cherty silt loam, hilly phase, are included in this phase because they are too small to delineate on the soil map or because the boundary between the two phases is not clear.

Present use and management.—Where Fullerton cherty silt loam, hilly phase, is cleared, use and management are now poorly adjusted to its physical properties. An estimated 40 percent of the soil is in forest. About 20 percent of the cleared land is used for corn, 20 percent for hay, and 20 percent for pasture. Most of the rest is idle land, but small acreages are in tobacco and small grains.

Systematic rotation of crops is not commonly practiced. Corn is grown for a few years until yields become totally unprofitable, and the soil is then allowed to rest for several years or it is abandoned. Lespedeza is the principal hay crop, but some timothy and redbud are also grown. Most pastures are chiefly broomsedge, but some are lespedeza.

Small quantities of commercial fertilizer are used on corn and small grains, but tobacco is fertilized fairly heavily. Little of the soil is ever limed. Contour tillage is practiced in many places, but no other special methods for controlling erosion are used.

Under common management the average acre yield of corn is 15 bushels; wheat, 8 bushels; burley tobacco, 600 pounds; and lespedeza or mixed hay, 0.5 ton.

Management requirements.—Where cropland is scarce and Fullerton cherty silt loam, hilly phase, must be used for crops, careful management is needed, and practices similar to those described for the hilly phase of Fullerton silt loam are required.

Wherever feasible from the standpoint of good farm management, the soil should be used for pasture because it has relatively low fer-

tility and is poor in moisture conditions, workability, and conservability. Bluegrass, white clover, orchard grass, redbud, lespedeza, hop clover, bur-clover, and Bermuda grass are among the pasture plants suited to the soil. A mixture of bluegrass and legumes makes pastures of good quality and highest carrying capacity. On some of the more severely eroded areas pastures of Bermuda grass and lespedeza are appropriate. If these are properly managed they improve soil conditions so that better pastures may be established at a later time. Moderate to heavy applications of phosphorus are necessary for pastures, and potash is possibly needed. Soil acidity can be corrected by lime applied in small or medium quantities at relatively frequent intervals, perhaps every third year.

Clipping pastures may be necessary to control weeds. Grazing should be carefully controlled to prevent injury to pasture stands and erosion. Such control is especially important during periods of adverse moisture conditions. Gullies should be stabilized by check dams and tree plantings. Thin shading by widely spaced locust trees is beneficial, especially where bluegrass is grown.

Much of this soil is far from springs or flowing streams, and furnishing water to livestock on the pastures is therefore a serious problem. Ponds or reservoirs for collecting and storing rain are necessary where water cannot be piped from springs, wells, or cisterns.

Fullerton cherty silt loam, rolling phase.—This phase has gray cherty surface soil and reddish cherty subsoil. It is relatively low in fertility, moderately difficult to work, and fairly easy to conserve and is poor to fair cropland. The soil is on ridge crests underlain by cherty dolomite or dolomitic limestone and was developed under hardwood forests of oak, hickory, blackgum, sweetgum, and dogwood. Slopes range from 5 to 12 percent. Both surface and internal drainage are good.

A large part of the soil is in narrow elongated areas on Chestnut, Hinds, and Copper Ridges, but it occurs in all of the cherty ridge areas. It is associated chiefly with Clarksville soils and other members of its own series, but Bolton or Claiborne soils may be on some of the adjoining steep slopes, especially those facing north and east.

The profile of this phase is similar to that of Fullerton silt loam, rolling phase, but there is much more chert on the surface and in the soil. The following describes a representative profile:

0 to 12 inches, brownish-gray loose light cherty silt loam.

12 to 36 inches, yellowish-red moderately friable cherty silty clay loam with a well-defined nut structure.

36 inches +, red cherty silty clay mottled with yellow, brown, and gray.

Cherty dolomite bedrock is at depths of 30 to 50 feet or more.

The soil is strongly to very strongly acid and low in humus, lime, and plant nutrients. It is permeable to water, roots, and air but moderately difficult to work because of the large quantity of chert on the surface and in the soil. Water is readily absorbed, and the loss of soil material through erosion is probably less than on Fullerton silt loam, rolling phase. In some places part of the surface layer has been lost through erosion, but enough remains to form the plow layer, and ordinarily the subsoil is not turned by tillage operations.

Significant variations in this phase are those due to differences in chertiness and texture. In some places the fine soil material has been

lost from the original surface layer because of accelerated erosion, and the present surface soil is largely a mass of angular chert fragments. This variation is not of large extent and it is indicated on the soil map by symbols. Areas of Clarksville soils are included where they are too small to delineate on the map or where the boundary between this phase and the Clarksville soils is not clear.

Present use and management.—The use of Fullerton cherty silt loam, rolling phase, is fairly well adjusted to soil characteristics over most of its extent, but in few places are management practices designed to compensate for soil deficiencies. An estimated 15 percent of the soil is now in forest. About 30 percent of the cleared soil is used for corn, 25 percent for hay and pasture, and 15 percent for other crops. The remaining 30 percent is idle.

As with most other Fullerton soils, rotation of crops is not generally practiced. A few of the better farmers use a rotation in which a row crop is followed by small grain seeded to hay, usually lespedeza. Lespedeza is the most common hay and pasture crop, but some timothy and redtop are also grown. In many places corn may be grown for several years in succession, and then the soil is left idle for several years, or until it is again needed for crops.

Corn and wheat receive about 100 pounds of 0-10-4 fertilizer. Ordinarily, no fertilizer is used on hay and pasture. Tobacco receives heavy applications of complete high-grade fertilizer or, where available, barnyard manure plus superphosphate. Only a small part of the soil is limed at regular intervals. Practically no special practices for controlling runoff are used.

Under prevailing management the average acre yield of corn is about 22 bushels; wheat, 12 bushels; burley tobacco, 800 pounds; and lespedeza hay, 0.6 ton. Where lime is used in addition to other common practices, red clover yields about 0.9 ton an acre and alfalfa 1.6 tons.

Management requirements.—Good management of Fullerton cherty silt loam, rolling phase, requires practices similar to those for Fullerton silt loam, rolling phase, and in addition, methods for improving workability.

Apparently the soil can be conserved under a rotation including a row crop once in 4 years, provided other management requirements are met. A row crop followed by small grain seeded to a legume or grass makes a desirable rotation. Legumes should have a prominent place in the rotation because they are effective in increasing the humus supply, and, in turn, the humus increases nitrogen content and improves tilth and moisture conditions. Corn, burley tobacco, soybeans, cowpeas, wheat, barley, oats, lespedeza, red clover, timothy, redtop, and tomatoes and other vegetables are among the crops suited to the soil. Fruit trees can be expected to do well if properly managed.

All crops require liberal applications of fertilizer. Corn, small grains, and grasses require complete fertilizer containing moderate quantities of nitrogen and potash and large quantities of phosphorus. Tobacco and vegetables have similar needs, but the proportion of potash should be somewhat higher. Legumes require large quantities of both phosphorus and potash but ordinarily no nitrogen. Lime is necessary to establish and maintain stands of legumes, and it in-

creases yields of other crops. Lime should be applied in small or medium quantities at rather frequent intervals.

Contour tillage can be used where practicable as an aid in conserving moisture and preventing erosion, and strip cropping may be useful, especially on the longer slopes. Terraces may be beneficial in some places; but they must be carefully planned, constructed, and maintained to be effective.

Under good management corn yields 33 bushels; wheat, 18 bushels; burley tobacco, 1,100 pounds; and lespedeza, 1.1 tons.

Fullerton cherty silt loam, steep phase.—Like other Fullerton soils, this phase has gray surface soil and red subsoil and was developed under a mixed forest of oak, hickory, sweetgum, blackgum, and dogwood. Apparently there was considerable shortleaf pine in some places. The soil is low in fertility, very difficult to work, and very difficult to conserve. It is on the slopes of ridges underlain by cherty dolomite or dolomitic limestone. Slopes range from 25 to 50 percent—the greater part from 30 to 40 percent. Internal drainage is moderate and external drainage very rapid.

Although most of this soil is on steep slopes adjacent to the Powell River and its tributaries, it occurs throughout all the cherty ridge area. The relatively broad, long, continuous strips making up the large areas of this soil are associated chiefly with Clarksville and other Fullerton soils on the ridges and with Greendale, Sequatchie, and Roane soils in the adjoining colluvial lands, terrace lands, and bottom lands. Small areas are associated with Bolton or Claiborne soils on the steep slopes at the heads of intermittent drains.

The profile of this phase is similar to that of the rolling phase, but the thickness of the various layers may be somewhat less. Angular chert fragments 1 to 10 inches or more in size make up more than half of the subsoil and substrata layers. Cherty dolomite bedrock is at depths of 10 feet or more; but the rock floor is somewhat jagged and uneven, and bedrock crops out on the surface in some places, especially near the foot of slopes.

The soil is strongly to very strongly acid. The upper few inches of the surface soil contains a small or medium amount of humus, but this part is entirely missing in most cleared areas. In such places the upper part of the original subsoil now forms the surface layer, and the content of organic matter is very low, good tilth is difficult to maintain, and moisture conditions are poor for plant growth. The surface layer is very cherty because erosion has removed the fine material in the original surface soil.

The chief variations in this phase are due to the degree of accelerated erosion and the quantity of chert on the surface and in the soil. Small areas of Clarksville cherty silt loam, steep phase, or Claiborne silt loam, steep phase, may be included either because they are too small to map separately or because the boundaries between the soils are not clear. Also included with this separation is a small area with slopes in excess of 50 percent.

Present use and management.—About 85 percent of Fullerton cherty silt loam, steep phase, is in forest and 10 percent in pasture; the rest is used for crops. Corn is grown 1 or 2 years, and the soil is then allowed to rest or is abandoned for several years. During this

time a sod of broomsedge and other wild grasses and brush becomes established. In some places these uncultivated fields are used for pasture; others are idle or wasteland. In a few places lespedeza may be sowed for hay or pasture. Soil amendments are not ordinarily used on corn, hay, or pasture.

Where the land is used for row crops and then left idle or in poor pasture for several years, it is soon depleted to the point where it is of little use to the farmer, and it is eventually abandoned to second growth forest. In general forests are not well managed. Ordinarily they are not protected from fires or grazing, and selective cutting is not practiced.

Management requirements.—Because of steep slopes, chertiness, natural poverty in plant nutrients, and poor moisture conditions, Fullerton cherty silt loam, steep phase, is not suited to crop or pasture. Management requirements for crops or pasture would be so exacting and costly that the yields obtained probably would not return a profit to the farmer under present conditions. The soil is therefore best used entirely for forests. The use and management of forest lands is discussed in the section on Forests.

Fullerton loam, rolling phase.—This phase has gray loam surface soil and red clayey subsoil. It is moderately low in fertility, moderately eroded, and is physically fair cropland. The soil is on the crests of ridges underlain by cherty dolomite or dolomitic limestone containing layers of calcareous sandstone, and it was developed under a mixed forest of oak, hickory, chestnut, blackgum, sweetgum, dogwood, and shortleaf pine. Slopes range from 5 to 12 percent. Both external and internal drainage are moderate.

Like other Fullerton soils, this phase occurs throughout the cherty ridge area. It is chiefly in small irregularly shaped bodies, but some is in long narrow strips. This phase is associated chiefly with other Fullerton loams, and with Claiborne and Bolton soils.

The profile of this phase is similar to that of the rolling phase of Fullerton silt loam except that it is lighter textured in the upper layers.

A profile description follows:

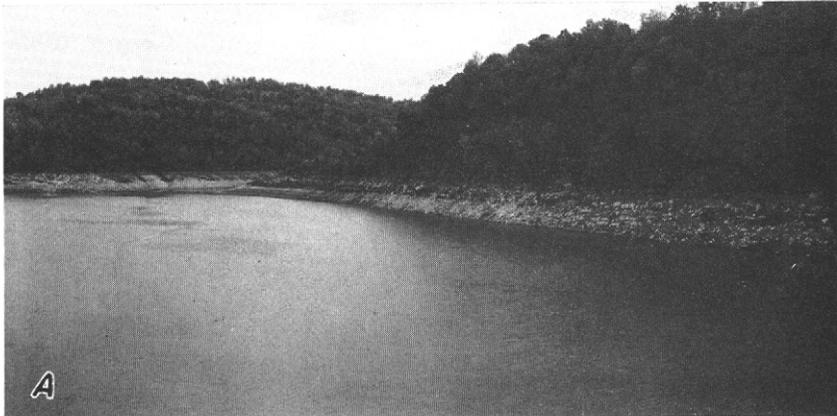
0 to 12 inches, gray or brownish-gray loose loam or fine sandy loam.

12 to 32 inches, yellowish-red moderately friable silty clay loam with a well-developed nut structure.

32 inches +, red cherty silty clay mottled with gray and yellow.

A few fragments of angular chert and fine sandstone are on the surface and in the surface soil and subsoil. Cherty sandy dolomite is at depths of 30 to 50 feet.

Originally the surface layer was about 12 inches thick, but under cultivation part of this layer has been lost through accelerated erosion. In most places, however, enough remains to form the present plow layer. Much of the original organic matter has been dissipated by cropping and through erosion losses, and the content is now very low. The soil is strongly acid. It is permeable to air, plant roots, and moisture. Moisture conditions for plant growth are generally fair; but because of the lighter texture and the lower water-holding capacity of this soil, crops may be more severely injured by droughts than on Fullerton silt loam, rolling phase. Good tilth is easily maintained, and tillage can be carried on over a fairly wide range of moisture conditions.



A



B



C

A, Norris Lake in foreground covers about 30,000 acres in the Norris area ; forest in background on land not well suited to tillage.
B, Fullerton soils are relatively thick over bedrock and are fairly permeable; corn on these soils having a slope of about 25 percent or less in background.
C, Broadly rolling to hilly cleared landscape of Fullerton soils used for general farm crops, as corn, small grains, and hay, especially lespedeza, in foreground contrasts strikingly with steeper, sharp, irregular forested area of Lehigh soils in background.



A, Pasture on Leadvale silt loam, rolling phase, in foreground; forest on hilly deep and steep phases of Montevallo shaly silt loam in background.
B, Pasture on Lehew soils on slopes; Leadvale silt loam, undulating phase, lies along the drains in center.
C, Forest on Lehew fine sandy loam, steep phase, in background; corn growing on this soil yields low returns, as the necessary culture exposes the soil to erosion.

The chief variations included are due to indistinct boundaries between this phase and associated soils or to the inclusion of areas of other soils too small to delineate on the map. Such inclusions consist of small areas of Fullerton and Claiborne silt loams, or of Clarksville loam, rolling phase. In some places, the subsoil may be fine sandy clay and may range from brownish red to bright red. A small area with a slope of 2 to 5 percent is also included. The variations included are small in extent and do not affect the general use suitability or management requirements of the phase.

Present use and management.—The use of Fullerton loam, rolling phase, is fairly well adjusted to its physical suitability, but management practices generally are not designed to compensate for soil deficiencies. Practically all the soil is cleared. About 25 percent is used for corn, 35 percent for hay, and 10 percent for tobacco and other crops. About 30 percent is idle land.

A few farmers use a rotation in which a row crop is followed by small grain seeded to lespedeza, but systematic rotations are not used extensively. The soil is often used successive years for corn, tobacco, and vegetables and then left idle for an extended period or allowed to grow up to broomsedge and wild grasses that are used for hay or pasture.

Corn and small grains are fertilized lightly with 0-10-4 mixture. Tobacco and vegetables receive moderate to heavy applications of a complete commercial fertilizer such as 3-8-6. Perhaps as much as a fourth of the soil is limed at periodic intervals. No special methods for controlling runoff and preventing erosion are ordinarily practiced.

Under prevailing management practices corn yields about 20 bushels an acre; wheat, 13 bushels; burley tobacco, 900 pounds; and lespedeza or mixed hay, 0.9 ton. Where lime is used in addition to other common practices red clover yields about 0.9 tons and alfalfa 1.8 tons.

Management requirements.—Fulleton loam, rolling phase, requires management very similar to that suggested for the rolling phase of Fullerton silt loam. A 3- or 4-year rotation well suited to the soil is a row crop seeded to small grain and followed by a legume for hay or pasture. Corn, soybeans, small grains, burley tobacco, potatoes, sweetpotatoes, tomatoes and other vegetables, lespedeza, red clover, timothy, small fruits, and tree fruits are among the crops suited to the soil. Deep-rooted legumes should have a prominent place in the rotation because they increase the contents of humus and nitrogen, improve tilth, and increase the water-absorbing properties of the soil. Barnyard manure is useful in these respects and also furnishes some potash, but it should be supplemented with phosphorus to obtain a proper balance of plant nutrients.

Fertilizer is required by all crops. Small or medium quantities applied to meet the needs of the individual crops are more effective than one or two large applications during a rotation. Corn and small grains require complete fertilizer containing medium quantities of nitrogen and potash and large quantities of phosphorus. Vegetables and burley tobacco need similar fertilizer, though the proportion of potash should be larger. Legumes require large quantities of both potash and phosphorus but ordinarily need no nitrogen. Lime in small or medium amounts should be applied once during each rotation, preferably immediately before seeding the legume.

Contour tillage can be practiced as an aid in conserving soil moisture and preventing erosion. Strip cropping may be useful in water control, and carefully planned, constructed, and maintained terraces may be effective in some places. Under good management corn yields 35 bushels an acre; wheat, 18 bushels; burley tobacco, 1,200 pounds; and lespedeza, 1.2 tons.

Fullerton silt loam, hilly phase.—Stronger slopes constitute the chief difference between this soil and the rolling phase of Fullerton silt loam. This phase has gray silt loam surface soil and red clayey subsoil, and it is moderately eroded and moderately low in fertility. Physically it is poor to fair cropland. The soil is in the uplands on the slopes of cherty ridges underlain by dolomite or dolomitic limestone. It developed under a mixed forest of oak, hickory, sweetgum, blackgum, shortleaf pine, and dogwood. Slopes range from 12 to 25 percent. External drainage is rapid and internal drainage moderate. This phase is mainly associated with other Fullerton soils, but also with those of the Clarksville, Claiborne, and Bolton series. It occurs throughout all of the cherty ridge area.

The profile is essentially the same as that of Fullerton silt loam, rolling phase, except that more of the original surface layer has been lost through erosion. Many small tracts have lost all the original surface layer, and in these the present plow layer is the upper part of the original subsoil. In such places the surface is hard when dry and sticky when wet, and good tilth is maintained with difficulty. The rest of the soil generally has favorable tilth. The present content of organic matter is low because of losses through erosion and cropping. The soil is strongly acid and moderately low in potassium, phosphorus, and nitrogen. It is permeable to moisture, air, and plant roots; but because of the stronger slopes and eroded condition, is less permeable than Fullerton silt loam, rolling phase. Loss of water through runoff is greater, and moisture conditions for plant growth are generally less favorable.

The principal variations included in this phase, other than those resulting from differences in erosion already described, are due to differences in texture and to indistinct boundaries between this and associated soils. In many places the boundary between this phase and some associated soil of the Clarksville or Claiborne series is not clear, and small areas of those soils may be included with this one in mapping. This kind of variation is especially common where the soil is immediately associated with Fullerton cherty silt loam, hilly phase.

Present use and management.—Fullerton silt loam, hilly phase, is generally used and managed in a manner not well adjusted to its physical properties. About 20 percent of this phase is in forest. An estimated 20 percent of the cultivated area is used for corn, 20 percent for hay, 25 percent for pasture, and 10 percent for other crops (pl. 1, C). The remaining 25 percent is idle.

Systematic rotation of crops is not ordinarily practiced. Corn is grown several years in succession and then followed by lespedeza hay or pasture, or the land is left idle for several years. Idle fields grow up to broomsedge, blackberries, persimmon, and sassafras, which are removed before the soil is again used for crops.

Corn and small grain receive small applications of 0-10-4 fertilizer or similar materials. Hay and pastures ordinarily are not fertilized. Little of the soil ever receives lime. Much of the soil is tilled on the contour, largely from necessity. A few farmers have constructed hillside ditches to remove excess water, but carefully planned special methods for controlling and conserving water and preventing erosion are not generally used. Under common systems of management corn yields about 18 bushels an acre; wheat, 9 bushels; and lespedeza or mixed hay, 0.8 ton.

Management requirements.—Where used for growing crops, Fullerton silt loam, hilly phase, is exacting in requirements for good management. Supplying lime, nitrogen, and mineral plant nutrients; increasing the humus content; proper choice and rotation of crops; and conservation of moisture and control of erosion are necessary.

When other management requirements are met, the soil can be conserved under a rotation including a row crop once in 6 years. Corn followed by a small grain seeded to legumes or grasses for hay or pasture makes a desirable rotation. Corn, soybeans, wheat, barley, oats, red clover, lespedeza, timothy, and redtop are among the crops well suited to the soil. Fruit trees can be expected to do well. Alfalfa can be grown but it requires large applications of soil amendments. This and other legumes are effective in increasing nitrogen and humus supplies and in binding the soil mass and are therefore valuable in increasing absorption of water and greatly reducing runoff and erosion.

Corn and small grains require moderate to large applications of complete fertilizer medium in content of nitrogen and potash and high in phosphorus. Legumes need large quantities of phosphorus and potash but ordinarily require no nitrogen. Lime in moderate quantities is necessary to obtain a good stand of legumes and insure their continued growth, and it also increases the yields of other crops. The lime should be applied before the legume crop in the rotation is seeded.

Tillage can be accomplished over a fairly wide range of moisture conditions, except where the soil is severely eroded, and it should be on the contour wherever the soil is used for crops. A system of strip cropping may be feasible on some of the longer slopes. Terracing seems to be impractical over much of the soil because of the strong slopes, but it may be useful in conserving moisture and preventing erosion in some places. Terraces must be carefully planned, constructed, and maintained to be effective. Under good management corn yields about 30 bushels an acre; wheat, 16 bushels; and lespedeza, 1.2 tons.

Severely eroded areas of this soil cannot be conserved if used as cropland, and therefore they should be used entirely for pasture. A pasture of bluegrass and white clover is desirable but it requires lime at periodic intervals, and phosphorus and potash to establish and maintain the stand. Lespedeza, orchard grass, redtop, and Bermuda grass are other useful pasture plants. They are generally less exacting in their requirements for amendments but produce pasture of lower quality. Grazing should be carefully regulated during periods of extreme moisture conditions to prevent injury to the pasture stand.

Weeds can be controlled largely through proper fertilization and regulated grazing, but clipping pastures once or twice a year may be necessary to eradicate undesirable plants. Shading by thinly spaced black locust or walnut trees may be beneficial.

On well-established and carefully managed pastures there are no serious problems of erosion control, but some special practices may be required in order to obtain good stands. In all places gullies should be controlled by check dams, and in some, terraces may be needed to stabilize the soil and establish moisture conditions that will permit the growth of good sods. Contour furrowing and seeding are excellent means of preventing erosion and conserving soil moisture for pasture plants.

Fullerton silt loam, rolling phase.—Like other Fullerton soils, this phase has gray surface soil and red subsoil. It differs from the rolling phase of Fullerton loam in being somewhat heavier in texture throughout the profile. It is relatively low in fertility, but is comparatively easy to work and conserve, and is fair to good cropland. The soil is on the crests of cherty ridges and has developed from parent material weathered from cherty dolomite or dolomitic limestone. It was originally covered with a mixed forest of hickory, sweetgum, blackgum, shortleaf pine, dogwood, and varieties of oak. Slopes range from 5 to 12 percent. Both external and internal drainage are moderate.

The soil is widely distributed in long narrow strips through all the cherty ridge area and is closely associated with other Fullerton soils, those of the Clarksville and Claiborne series, and to a lesser extent, with Bolton soils. It is darker and less cherty than comparable Clarksville soils but lighter in color and more cherty than Bolton or Claiborne soils.

Following is a profile description :

- 0 to 12 inches, gray to brownish-gray friable silt loam.
- 12 to 42 inches, yellowish-red moderately friable silty clay loam with a well-developed nut structure.
- 42 inches +, red or yellowish-red cherty silty clay splotched with gray, rust brown, and yellow.

Some angular chert fragments are on the surface and in the soil. Cherty dolomite bedrock is at depths of 30 feet or more.

On most cleared and cultivated areas a part of the surface layer has been lost through erosion; but in nearly all places enough remains to form the plow layer, and the subsoil is not turned by tillage, operations. Tillage can be accomplished over a wide range of moisture conditions. The original content of humus was probably relatively low, and most of it has been dissipated through cropping and in erosion losses. The soil is strongly acid. It is permeable to soil moisture, air, and plant roots; and loss of moisture through surface runoff is not so severe as on the heavier limestone soils.

The principal variations included are those due to indistinct boundaries between this phase and some other Fullerton soil. For example, in many places this phase is adjacent to Fullerton cherty silt loam, rolling phase, and the soil gradually changes from silt loam to cherty silt loam over a considerable area. In such places the line between the two soils must be arbitrarily drawn somewhere in this transitional zone. Some small areas of cherty soil too small to delineate on the soil map are also included.

Present use and management.—The present use of Fullerton silt loam, rolling phase, is fairly well adjusted to its physical properties, but prevailing management practices are not designed to conserve the soil or to compensate for its deficiencies. Practically all of the land is cleared. About 20 percent is used for corn, 10 percent for small grain, 45 percent for hay and pasture, and 10 percent for other crops. The remaining 15 percent is idle. A few of the better farmers use a rotation of corn, small grain, and hay; but much of the land is used for row crops several years in succession, and after the soil has been depleted, it is allowed to lie idle for several years.

Corn and small grains ordinarily receive about 100 pounds of 0-10-4 fertilizer. Tobacco is given heavy applications of a complete high-grade commercial fertilizer, and vegetables usually receive at least moderate applications. Where available, barnyard manure is used on all row crops. Hay and pastures are not ordinarily fertilized, and only a small acreage of the soil is limed at periodic intervals. Some farmers practice contour tillage, but other special methods for controlling runoff and preventing erosion are not ordinarily used.

Under common management corn yields about 23 bushels an acre; wheat, 14 bushels; burley tobacco, 900 pounds; and lespedeza hay, 0.9 ton. Where lime is used in addition to other common practices, red clover yields about 1 ton an acre and alfalfa 1.8 tons.

Management requirements.—Supplying lime and mineral plant nutrients, increasing humus content, and the proper choice and rotation of crops are special management requirements for Fullerton silt loam, rolling phase. These requirements can be met without difficulty on this soil. Some special practices for control of runoff also are needed.

A rotation including a row crop once in 4 years is well suited to the soil. Corn, small grains, lespedeza, red clover, timothy, tomatoes and other vegetables, and fruits do well. The better farmers report that the soil is especially well suited to burley tobacco and that crops of excellent quality are obtained, although yields are not so high as on the soils of the limestone valleys. Alfalfa can be successfully grown if limed and heavily fertilized. This and other legumes are effective in increasing the supply of humus and nitrogen, in improving the tilth of the surface soil, and in controlling runoff.

Corn and small grains require large applications of phosphorus and moderate quantities of nitrogen and potash; whereas tobacco and vegetables need large applications of both phosphorus and potash and, where legumes are included in the rotation, small to moderate quantities of nitrogen. These requirements can probably best be met by using high-grade complete commercial fertilizer. Legumes require large quantities of both phosphorus and potash, but no nitrogen. Barnyard manure is effective in increasing supplies of humus and nitrogen and in furnishing potash, but it should be supplemented with phosphate fertilizer to obtain a proper balance of plant nutrients. Lime is essential to legumes and gives increased yields of other crops. It may be assumed from the properties of the soil that small to medium quantities of lime at moderately frequent intervals should be applied, but there is little definite data to support the assumption. Lime is best applied immediately before the legume in the rotation is seeded.

Tillage can be successfully accomplished over a fairly wide range of moisture conditions. Where practical, all tillage operations should

be on the contour. Carefully planned and constructed broad-base terraces are effective in conserving moisture and preventing erosion if they are properly maintained.

Under good management corn yields 38 bushels an acre; wheat, 20 bushels; burley tobacco, 1,200 pounds; and lespedeza hay, 1.3 tons.

Fullerton silt loam, steep phase.—Although this soil is similar to Fullerton silt loam, rolling phase, in having gray surface soil and red subsoil, it differs in having much steeper slopes. Fertility is relatively low. The soil is on the steep slopes of cherty ridges underlain by cherty dolomite or dolomitic limestone and was developed under a deciduous forest of oak, hickory, blackgum, sweetgum, dogwood, and possibly shortleaf pine in some places. Slopes range from 25 to 35 percent or more. Surface drainage is very rapid, and internal drainage is moderate.

Most of this soil is in comparatively small areas associated with Clarksville, Claiborne, Bolton, and other Fullerton soils on hilly and steep slopes, but it occurs throughout all the cherty ridge area. It is one of the less important of the Fullerton soils.

The profile of this phase is similar to that of Fullerton silt loam, rolling phase, but the various layers may be somewhat thinner. In cleared areas more of the original surface soil has been lost through accelerated erosion, and in severely eroded places this layer may be missing. In such places the original subsoil is at the surface and, favorable tilth is maintained with difficulty. The soil is strongly acid and is very low in organic matter because the original small supply has been depleted through cropping and erosion. It is permeable to moisture, plant roots, and air; but moisture conditions for plant growth are only fair because so much water runs off the steep slopes. Some angular chert fragments are on the surface and in the soil. Cherty dolomite bedrock is at depths of 20 feet or more.

The principal variations in this phase are due to differences in degree of accelerated erosion. In contrast to the cleared areas, the soil that remains in forest has retained all of the original surface soil, or a layer about 10 inches thick. In some places the boundary between this soil and some associated soil is not sharp, and small areas of other steep phases of Fullerton, Clarksville, and Claiborne soils may be included.

Present use and management.—An estimated 20 percent of Fullerton silt loam, steep phase, is now in forest. About 20 percent of the cleared land is used for corn, 20 percent for hay, 25 percent for pasture, and 10 percent for other field crops. The remaining 25 percent is idle or wasteland.

Use and management are not well adjusted to the properties of the soil. Crops are not rotated, and corn is grown for several years or until the fertility of the soil is exhausted to the point where yields are very low. The land may then be abandoned for several years. Lespedeza is the chief hay crop, and pastures are of poor quality, often consisting chiefly of broomsedge. Small quantities of fertilizer are used on corn, but none is ordinarily used on hay or pasture. Little of the soil receives lime. From necessity, tillage is on the contour, but no special practices for controlling runoff and preventing erosion are used.

Management requirements.—Fullerton silt loam, steep phase, is so difficult to conserve and work that it is not suitable for cropland. Where properly managed, it may produce fairly good pasture. Bluegrass, white clover, redbud, orchard grass, Bermuda grass, and lespezeza are among the forage plants that may be used in pasture mixtures.

Legumes or legume grass mixtures need fairly heavy applications of phosphorus and potash. Grasses require nitrogen in addition. Lime, applied at periodic intervals, is necessary to establish and maintain good pasture stands. Grazing should be controlled during extremely wet or dry periods to avoid damage to pastures. Weeds can be controlled largely by proper use of the soil amendments and careful grazing, but clipping may be needed to remove some excess herbage.

Gullies should be stabilized. Other means for control of runoff and erosion are not ordinarily needed, because the roots of pasture plants effectively bind the soil mass and greatly increase its water-absorbing properties. Thinly spaced plantings of black locust and walnut are beneficial on bluegrass pastures.

Fullerton silt loam, undulating phase.—Like other Fullerton soils, this phase has gray surface and red subsoil. It differs from Fullerton loam, rolling phase, chiefly in having milder slopes. The soil is low in fertility but relatively easy to work and conserve and is fair to good cropland. Slopes range from 2 to 5 percent. Both external and internal drainage are good. This phase has developed on ridge crests from the residuum of cherty dolomite under a mixed forest of oak, hickory, sweetgum, blackgum, shortleaf pine, and dogwood. It is distributed throughout the cherty ridge area in association with other Fullerton soils and those of the Clarksville, Claiborne, and Bolton series.

This soil has the following profile:

0 to 12 inches, gray to brownish-gray friable silt loam.

12 to 42 inches, yellowish-red moderately friable silty clay loam.

42 inches +, yellowish-red cherty silty clay splotched with gray, rust brown, and yellow.

Some chert fragments are on the surface and throughout the soil. Bedrock is at depths of 30 feet or more.

On most cleared areas part of the original surface soil has been lost through erosion but in most places enough remains to form the plow layer. Tillage is accomplished over a wide range of moisture conditions without seriously impairing tilth. The original content of humus was probably relatively low, and most of it has been dissipated through cropping and erosion. The soil is permeable, and surface runoff is not so severe as on heavier limestone soils. It is strongly acid.

Present use and management.—Practically all of Fullerton silt loam, undulating phase, is cleared and cultivated. An estimated 25 percent is used for corn, 15 percent for small grains, 35 percent for hay and pasture, 15 percent for other crops, and 10 percent is idle. Systematic rotation of crops is not commonly used, and the fertilization practiced is inadequate for crop needs. Tobacco usually receives a heavy application of high-grade fertilizer, vegetables a moderate quantity, and

feed and forage crops a very light application. Only a small portion of the soil is adequately limed.

Under common management practices corn yields about 25 bushels an acre; wheat, 14 bushels; burley tobacco, 1,000 pounds; and lespe-deza hay, 1 ton.

Management requirements.—Fullerton silt loam, undulating phase, is similar to the rolling phase in management requirements. Owing to the milder relief, however, a row crop can be used more frequently in the rotation and special practices for runoff control are not so necessary. Under good management corn yields 40 bushels an acre; wheat, 22 bushels; burley tobacco, 1,300 pounds; and lespe-deza, 1.4 tons.

Greendale silt loam, rolling phase.—The stronger slopes of this phase differentiate it from the undulating phase. The soil is acid, moderately fertile, and moderately cherty and has a grayish surface layer and a yellow subsoil. It is fair to good cropland. The areas are on sloping benches and foot slopes along intermittent streams and in the bottoms of large lime sinks in the cherty ridges. The parent material is derived from local alluvium and colluvium washed chiefly from the Clarksville and Fullerton soils of adjoining uplands. The soil was originally covered by hardwood forests. It has slopes of 7 to 16 percent, although they are usually less than 12 percent. Both surface and internal drainage are moderate.

The soil occurs in small narrow strips or small irregularly shaped tracts. Clarksville and Fullerton soils are in the adjacent uplands; and Greendale and Emory silt loams, undulating phases, and Roane silt loam are in the colluvial lands and nearby bottom lands.

This phase is very similar to the undulating phase, although its various layers may be thinner and the total depth of material less. The soil is low in organic matter and medium acid. Soil moisture conditions are fairly good, but they are less favorable than in the undulating phase because of the stronger slopes and the consequent greater loss of water through runoff. Good tilth is fairly easy to maintain. There is a small or moderate amount of chert on the surface and in the soil. On the stronger slopes where the soil has been intensively used, a large part of the surface layer may be missing or it may be buried under chert and heavy subsoil materials that have washed from the adjoining upland soils. In all these places good tilth is more difficult to maintain, moisture conditions are poorer, and the soil is less productive. In most places bedrock is at a depth of many feet.

Present use and management.—The use of practically all Greendale silt loam, rolling phase, is fairly well adjusted to its physical properties; but because it is more exacting in its requirements, management is not so well adjusted as on the undulating phase. Essentially the same management practices are used on both soils. All the soil is now cleared and cultivated. About 30 percent is used for corn, 20 percent for pasture, 10 percent for small grains, and 10 percent for other field crops. Small acreages are used for raising vegetables; but most of the remaining 30 percent is used for hay, largely lespe-deza, timothy, and red clover. General management practices are practically the same as those described for the undulating phase, but yields are slightly lower. Under common management, corn yields about 25 bushels an acre; wheat, 10 bushels; burley tobacco, 900 pounds; lespe-deza, 0.7 ton; and timothy and clover, 1.2 tons.

Management requirements.—In comparison to most soils, Greendale silt loam, rolling phase, has simple requirements for good management; but they are more exacting than those of the undulating phase because of the stronger slopes, and some simple practices for controlling runoff and preventing erosion are necessary. The soil is suited to the same wide variety of crops as the undulating phase. Rotations similar to those described for that soil are well suited, except that special care should be taken to have winter cover crops on this soil each year. Row crops should be grown less frequently. The requirements for fertilizer and soil amendments are practically the same as those described for the undulating phase.

Contour tillage should be practiced to prevent excessive runoff. The runoff from adjoining uplands should be diverted from this soil, mainly to keep the surface soil from being covered by large quantities of chert and heavy subsoil material from severely eroded upland soils.

Greendale silt loam, undulating phase.—This phase is on well-drained nearly level foot slopes and benches, along small intermittent streams, and in the bottoms of lime sinks in cherty ridges. The colluvial and local alluvial parent materials have rolled and washed from uplands underlain by cherty dolomite or dolomitic limestone on which there are soils of the Fullerton and Clarksville series. The soil was developed under a hardwood forest similar to that on the adjoining upland soils; but the forest trees were likely larger on this phase because of its higher inherent fertility and more favorable moisture conditions. Slopes range from nearly level to 7 percent. Both surface and internal drainage are moderate.

The soil is in all of the cherty ridge area. Along the streams it is in long, narrow strips; but in the lime sinks the areas are small and irregularly shaped. Soils of the Clarksville and Fullerton series are on the adjoining uplands; and Greendale silt loam, rolling phase, and some Emory silt loam, undulating phase, are associated soils of the colluvial lands. Roane and Lindsides soils are on nearby bottom lands along some of the larger streams.

This is a young soil lacking a well-developed profile, but the following is representative:

0 to 8 inches, gray or light grayish-brown friable silt loam.

8 to 30 inches, yellowish-brown or brownish-yellow friable silt loam or light silty clay loam.

30 inches +, grayish or brownish colluvial soil material spotted with gray.

Small to moderate quantities of angular chert fragments are on the surface and in the soil. In most places bedrock is at depths of 30 feet or more.

Although low in organic matter, the soil has more than those of the adjoining uplands. It is medium acid and is low to medium in phosphorus and potash, but generally has a higher content of both than the associated Clarksville and Fullerton soils. Moisture conditions are favorable for plant growth because of the moisture-absorbing and retaining properties of the soil and the gradual movement of moisture from the surrounding uplands to this lower lying area. Tillage operations can be carried out over a moderately wide range of moisture conditions, and good tilth is maintained with ease. Where the supply of lime and organic matter has been depleted by poor management, however, the soil puddles or runs together if plowed when too wet.

Present use and management.—Practically all of Greendale silt loam, undulating phase, is used for purposes to which it is fairly well suited physically, but increased yields can be obtained in most places by using improved management practices. All the soil is cleared and cultivated. About 60 percent of it is used for corn, 30 percent for hay and pasture, and 10 percent for other field crops.

Lespedeza, red clover, and timothy are the chief hay crops. A rotation of corn, wheat, and lespedeza or red clover is used by some farmers; but systematic rotations are not generally practiced. Instead, corn or tobacco is raised for several successive years and then followed by hay or wheat.

Less than half of the soil is limed at regular intervals. Tobacco is usually fertilized heavily with a high-grade complete fertilizer, and where available, barnyard manure supplemented with superphosphate is applied. Wheat and corn receive a small quantity of 0-10-4 fertilizer or 16- or 20-percent superphosphate. Hay crops are not ordinarily fertilized, but they receive some residual benefits from fertilizer applied to other crops.

Most tillage operations are done promptly as needed. In fact, many farmers use a large part of their time, labor, and capital on this soil because it is more productive and more responsive to management than the soils of the adjoining uplands.

Under common practices of management corn yields about 28 bushels an acre; wheat, 13 bushels; burley tobacco, 1,000 pounds; lespedeza, 0.8 ton; and red clover, 1.3 tons. The burley tobacco grown on this soil is of a high quality.

Management requirements.—Good management of Greendale silt loam, undulating phase, requires simple practices that can be accomplished with ease. They are chiefly the proper choice and rotation of crops and the correct use of fertilizer and soil amendments. The soil is suited to a wide variety of crops, including corn, burley tobacco, wheat, barley, oats, red clover, crimson clover, soybeans, timothy, potatoes, vegetables, and small fruits. It is suited to intensive use; and under careful management can be used for growing a row crop every other year. A row crop followed by small grain seeded to crimson clover is a useful rotation. The clover is turned under the following spring as green manure. Where a longer rotation can be used, one including corn, small grain, and red clover is well suited to the soil. Legumes are effective in increasing humus and nitrogen and improving tilth, but they require lime in small or medium quantities at rather frequent intervals. In addition to neutralizing soil acidity, lime furnishes calcium to the plants and increases friability and permeability of the soil.

Legumes require moderate to heavy applications of phosphorus and potash, and tobacco needs medium to large quantities of complete fertilizer containing large quantities of phosphorus and potash and medium or small amounts of nitrogen. Corn and small grains need similar fertilizer but in smaller quantities and with lower proportions of potash. The fertilizer requirements of potatoes and other vegetables are similar to those of tobacco. Barnyard manure is an excellent source of potash and nitrogen and also serves to increase humus, but it should be supplemented with phosphorus fertilizer to obtain the proper balance of plant nutrients. In some places runoff from adjoining

ing uplands should be controlled to prevent erosion and protect this soil from deposits of heavy subsoil material.

Hector stony fine sandy loam, steep phase.—This light-red soil of the uplands is associated with Muskingum and Lehew soils. It developed chiefly from parent material weathered from the underlying sandstone. The native vegetation was predominantly shortleaf pine and deciduous hardwoods, chiefly oak and hickory, and some chestnut. External drainage is very rapid and internal drainage moderate. The surface is steep, the gradient ranging upward from 30 percent but seldom exceeding 60 percent. A large part of the soil lies on the southeast slope of Big Ridge in association with Lehew and Muskingum soils.

Following is a profile description :

0 to 12 inches, grayish-brown moderately loose fine sandy loam.

12 to 36 inches, yellowish-red to reddish-brown, grading with depth to red, friable fine sandy clay.

36 inches +, red friable sandy clay loam spotted with yellow and gray.

Sandstone fragments are throughout the soil mass and are sufficiently abundant in places to prohibit tillage. The soil is medium to strongly acid, moderately fertile, and permeable to roots and moisture. Its capacity for holding water available to plants is fairly good. The depth to bedrock varies from less than 2 feet to possibly 5 feet, and because of erosion the thickness of the surface layer varies greatly. About 50 percent of the soil is virtually unaffected by erosion, but the rest has lost an appreciable part of the surface soil, and in small areas practically all of the surface soil and part of the subsoil are gone. A small acreage with a slope range of 15 to 30 percent is included with the separation.

Present use and management.—About half of Hector stony fine sandy loam, steep phase, has been cleared, but a large part of the cleared land has been abandoned to unimproved pasture or reestablished pine forest.

Management requirements.—A great part of Hector stony fine sandy loam, steep phase, probably is best used for pine forest. Chiefly because of its steep slope and stoniness, this soil is not well suited to either crops or pasture. Some of the cleared areas may be suitable for pasture if properly fertilized and managed. Such areas should be treated, particularly with phosphorus and lime, and seeded to such pasture plants as lespedeza, redbud, and orchard grass.

Jefferson stony fine sandy loam, rolling phase.—This stony phase has gray surface soil and yellow or brownish-yellow subsoil and occurs on nearly level to sloping well-drained fans and benches at the base of mountain slopes. It is physically poor to fair cropland. The parent materials are colluvium or local alluvium that has rolled or washed from Muskingum or Lehew soils of the adjoining uplands. The soil was developed under a mixed forest of oak, hickory, sourwood, sweetgum, dogwood, and shortleaf pine. In the mountain section hemlock, beech, maple, holly, and mountain-laurel are commonly on the soil. Slopes range from 5 to 15 percent. Both surface and internal drainage are moderate.

The soil occurs in small areas, chiefly at the foot of the Cumberland escarpment in Powell Valley, but also in Texas and Beard Valleys

and along the foot of Clinch Mountain. It is associated mainly with Allen soil in the colluvial lands, and with Talbott soils in the adjoining valley uplands. Muskingum soils are on the adjacent mountain slopes.

The profile is rather weakly developed and may vary somewhat from place to place, but the following description is representative of most of the soil:

0 to 10 inches, brownish-gray or yellowish-gray loose stony fine sandy loam.
10 to 36 inches, brownish-yellow friable light silty clay loam or sandy clay loam.

36 inches +, yellow sandy clay spotted with gray, brown, red, and yellow.

This colluvial deposit is several feet thick in most places and may be underlain by sandstone, shale, or limestone.

The soil is strongly acid, low in organic matter, and relatively poor in moisture-absorbing and retaining properties because of its light texture, stoniness, and low humus content. Plants are injured by lack of moisture even during short droughty periods. Sufficient fragments of sandstone are on the surface and in the soil to interfere with tillage; and good tilth is difficult to maintain because of stoniness, strong soil acidity, and low humus content.

The soil includes a few variations. The deposit of colluvial material ranges from as little as 3 feet to 15 feet or more deep. In the Cumberland Mountains the parent material is derived entirely from sandstone, whereas in the valley areas it may include some shale and a small quantity of limestone. A few areas of the soil are so stony that they cannot be cultivated, and a small acreage is relatively stone-free.

Present use and management.—The use of Jefferson stony fine sandy loam, rolling phase, is fairly well adjusted to its physical properties, but management practices designed to improve the soil or to compensate for its deficiencies are not common. More than 70 percent of the soil is cleared. Corn, lespedeza, tobacco, and vegetables are the chief crops; but small part is used for pasture, and some is idle. Crops are not ordinarily rotated. Row crops are raised a few successive years, and the soil is then seeded to lespedeza for hay or pasture. In some places the fields remain idle after the row crops and they grow up to broomsedge and brush. Tobacco receives moderate to large quantities of complete fertilizer; other crops are fertilized very lightly or not at all. Little of the soil is limed at regular intervals. No special attempt is made to conserve soil moisture.

Under prevailing systems of management corn yields about 15 bushels an acre; wheat, 6 bushels; burley tobacco, 600 pounds; and lespedeza or mixed hay, 0.5 ton.

Management requirements.—Jefferson stony fine sandy loam, rolling phase, is exacting in its requirements for good management because of stoniness, low fertility, strong acidity, and poor tilth and moisture conditions. Good management should be designed to improve or compensate for the various unfavorable features of the soil. If other requirements are met, the soil can be conserved under a rotation including a row crop once in 3 years. Vegetables, burley tobacco, corn, small grains, timothy, and clover are among the crops suited to the soil. Legumes are important in rotations, inasmuch as they increase the content of humus and nitrogen and improve tilth and moisture

conditions; but lime in small quantities at frequent intervals is necessary to obtain good stands of these plants.

All crops require fertilizer. Corn, small grains, and tobacco should receive a complete fertilizer containing nitrogen, phosphorus, and potash, with a relatively high proportion of potash for tobacco. The requirements of potatoes and other vegetables are similar to those of tobacco. Legumes need phosphorus and potash but no nitrogen. Fertilizer should be applied in relatively small amounts to meet the immediate needs of each crop rather than in large quantities at infrequent intervals.

Tilth is greatly improved when legumes that receive proper amendments are included in the rotation, and it can be further improved in most places by the removal of stones. Tillage should be on the contour, especially on the steeper slopes; but where the soil is carefully managed, other measures for preventing erosion and conserving soil moisture are generally unnecessary.

Under good management corn yields about 25 bushels an acre; wheat, 10 bushels; burley tobacco, 900 pounds; and lespedeza, 0.8 ton.

Leadvale silt loam, rolling phase.—Stronger slopes distinguish this soil from the undulating phase. It is a moderately to severely eroded yellow soil with a relatively heavy subsoil or substratum and is physically fair to good cropland. It occurs on imperfectly drained fans and benches at the foot of hills, chiefly in shale valleys. Parent materials are colluvium and local alluvium washed or rolled from the adjoining upland slopes, largely from Montevallo soils, but also from the Lehew and Armuchee. The soil developed under a mixed forest of oak, hickory, sourwood, and dogwood, with considerable pine on the less favorable sites. Slopes range from 7 to 15 percent, but most of them are less than 10 percent. Surface drainage is moderate, but internal drainage is rather slow because of the heavy subsoil.

Most of the soil is in Powell and Little Valleys, where the long narrow strips lie between the stream-bottom lands and the uplands. It is associated chiefly with Montevallo and Lehew soils, to a small extent with Armuchee soils in the uplands, and with Leadvale silt loam, undulating phase, and Philo fine sandy loam on the colluvial lands and bottom lands, respectively.

The profile of this soil is very similar to that of Leadvale silt loam, undulating phase, except that part of the original surface layer has been lost through accelerated erosion, and surface drainage is better because of the stronger slopes.

Because the soil is strongly acid, eroded, and low in organic matter, good tilth is moderately difficult to maintain. Moisture conditions are generally favorable for plant growth, but the upper soil may become saturated with water during prolonged or heavy rains. Most of the soil is free of stones, but small fragments of sandstone are on the surface in a few places.

The chief variations in the soil are due to differences in degree of erosion and in texture. In a few places practically all the original surface soil is missing and the upper subsoil is now the plow layer. In many places the layer of alluvium is thin and shale bedrock is at a depth of 3 feet or less. A few small areas have a fine sandy loam surface and a correspondingly lighter subsoil. The soil in Powell Valley contains some limestone material and is possibly somewhat

heavier in texture. Some of these variations, especially those due to erosion, may cause local variations in management requirements.

Present use and management.—The use of Leadvale silt loam, rolling phase, is similar to that of the undulating phase. It is used rather intensively, and management practices are not designed to correct or improve unfavorable soil conditions to any great extent. Practically all the soil is cleared. Probably half or more is used for row crops, chiefly corn, with smaller acreages in burley tobacco and vegetables. Most of the rest is in hay crops, chiefly lespedeza; but small severely eroded areas are idle or abandoned. A few of the better farmers use a rotation of a row crop, small grain, and hay; but in many places row crops are grown several years in succession and then followed by a few years of hay (pl. 2, A).

Burley tobacco receives moderate to large quantities of commercial fertilizer, but corn and small grains are fertilized only lightly and hay crops ordinarily not at all. Little of the soil is limed at periodic intervals. No special practices for preventing erosion are used. Under common management corn yields about 20 bushels an acre; wheat, 9 bushels; burley tobacco, 800 pounds; and lespedeza 0.6 ton.

Management requirements.—Good management of Leadvale silt loam, rolling phase, is very similar to that for the undulating phase, but more water-control practices are necessary. If other management requirements are met, the soil can be conserved under a rotation including a row crop once in 3 or 4 years, and well suited is a rotation in which a row crop is followed by small grain seeded to a legume or legume-grass mixture. This phase is fairly well suited to all the crops commonly grown in the area, with the probable exception of alfalfa, sweetclover, and other deep-rooted legumes; but such legumes as alsike, red, white, and possibly crimson clovers will do fairly well. Legumes should have an important part in any rotation, because they increase supplies of nitrogen and humus and improve tilth and moisture conditions.

Barnyard manure is another important source of organic matter and nitrogen and it also contains some potash. Manure should be used with phosphate fertilizer to obtain the correct balance of plant nutrients. To insure success with legumes soil acidity must be neutralized by applying ground limestone, which also supplies calcium to the plants and aids in improving tilth and moisture conditions. Corn and small grains need a complete fertilizer containing small to medium supplies of nitrogen and potash and relatively large quantities of phosphorus. The requirements of burley tobacco are similar, except that more potash is needed. Legumes or legume-grass mixtures require potash and phosphorus but ordinarily need no nitrogen. The requirements of potatoes, tomatoes, and many other vegetables are similar to those of tobacco. The use of lime and fertilizer in relatively small amounts to meet the immediate requirements of the crops is preferable to the use of large quantities at infrequent intervals.

Where suitable crops are correctly rotated and properly fertilized, tilth and moisture conditions are greatly improved and surface runoff and erosion are greatly reduced. Contour tillage is a good practice, however, and properly constructed and maintained broad-base terraces may be useful in conserving moisture and preventing erosion.

Under good management corn yields 30 bushels an acre; wheat, 12 bushels; burley tobacco, 1,000 pounds; and lespedeza, 1.1 tons.

Leadvale silt loam, undulating phase.—This phase occurs on imperfectly drained nearly level fans and benches in valleys at the foot of slopes underlain chiefly by acid shale. It is a yellow soil with a relatively heavy subsoil or substratum and is physically fair to good cropland (pl. 2, *B*). The parent materials are derived from colluvium or local alluvium rolled or washed from the nearby shale ridges. The soil was developed under a mixed forest of oak, hickory, sourwood, dogwood, and shortleaf pine. Slopes range from 2 to 7 percent, but the greater part of the soil has slopes near the lower limit of the range. Both surface and internal drainage are somewhat slow.

The soil is in Powell Valley and several of the valleys in the ridge-and-valley area. Montevallo soils are on the adjacent uplands in most places, but there are some Lehew soils. Philo soils are on the nearby bottom lands.

Although this is a relatively young soil, it has a distinct and characteristic profile, which is as follows:

0 to 12 inches, brownish-gray or yellowish-gray friable silt loam.

12 to 24 inches, brownish-yellow moderately friable silty clay loam.

24 inches +, yellow silty clay mottled with gray and brown; compact in place and apparently somewhat cemented.

The soil is low in organic matter and strongly acid in reaction. The moisture conditions are favorable for most crops except such deep-rooted legumes as alfalfa and sweetclover. During and following heavy rains the soil becomes saturated with water. Good tilth is fairly easy to maintain, but the soil becomes puddled or cloddy if plowed too wet.

The soil includes several variations. A few small areas have fine sandy loam surface soil and a correspondingly lighter subsoil. Some of the soil near the heads of small intermittent drains has a profile less distinctly developed than normal. In Powell Valley the soil contains some limestone material and is underlain in most places by limestone. In a few places there may be sandstone fragments on the surface. Some areas of the soil are eroded to a considerable extent, and acid shale bedrock is at shallow depths of from 2 to 3 feet. None of these variations are of sufficient extent to change materially the use suitability or management requirements of the soil.

Present use and management.—Leadvale silt loam, undulating phase, is one of the few soils in the shale valleys suited to growing crops, and it is therefore used rather intensively. All of it is cleared and cultivated. About 25 percent is used for corn, 40 percent for hay and forage crops, and 25 percent for small grain. Some 10 percent is in other crops or idle. Systematic rotation of crops is not practiced, and many farmers grow row crops as long as yields remain profitable. Little of the soil is ever idle. Moderate to large quantities of fertilizer are used on tobacco, but corn is fertilized lightly or not at all. No fertilizer is applied to hay. Only a small part of the soil is limed at regular intervals. A few farmers make some attempt to improve drainage by open ditches.

Under prevailing management practices corn yields about 25 bushels an acre; wheat, 13 bushels; burley tobacco, 900 pounds; and lespedeza hay, 0.7 ton. Where lime is used in addition to other common practices, red clover and timothy yield about 0.9 ton.

Management requirements.—Good management of Leadvale silt loam, undulating phase, can be accomplished rather easily. The correct choice and rotation of crops, the use of fertilizer and lime, and measures for improving moisture and tilth conditions are required. If other management requirements are met, the soil can be conserved under a rotation that includes a row crop once in 2 or 3 years. Most of the common field crops, with the possible exception of such deep-rooted legumes as alfalfa and sweetclover, are fairly well suited to the soil. Alsike clover, white clover, and possibly red clover will do well. Tobacco is not well suited to the more poorly drained areas. Legumes should have an important place in any rotation. In short rotations, winter oats and barley are excellent winter cover crops; and if turned under in the early spring, they are effective in supplying humus.

Where legumes are grown, lime is needed in small or medium quantities at moderately frequent intervals. Use of lime also increases yields of most other crops and helps to improve soil tilth. Corn and small grains need complete fertilizer containing moderate quantities of nitrogen and potash and large quantities of phosphorus. Tobacco, potatoes, and many other vegetables, require similar fertilizer, although the proportion of potash should be somewhat higher. Legumes require potash and phosphorus but no nitrogen, and other hay crops need a complete fertilizer. Fertilizer and other amendments should be applied in small or moderate quantities to meet the immediate needs of the crop being grown.

Care in the selection of correct moisture conditions for tillage is needed to prevent clodding or puddling of the surface soil. Surface drainage can be feasibly improved by the use of shallow open ditches in some places. It is doubtful whether tile drains would improve the yields or use suitability of the soil enough to justify the cost of their construction.

Lehew fine sandy loam, hilly phase.—Although similar to the steep phase, this soil is distinguished chiefly by its occurrence on the milder slopes (15 to 30 percent) of comby ridges. Moisture conditions may be slightly better because of the milder slopes, but conditions for plant growth are otherwise very similar in the two soils. This soil is low in fertility, difficult to work, and difficult to conserve. No significant variations except those due to differences in erosion were included in mapping.

The soil is in small areas on foot slopes, mainly in association with Lehew fine sandy loam, steep phase, but also with Montevallo and Armuchee soils. The profile is essentially the same as that of Lehew fine sandy loam, steep phase.

Present use and management.—The use of Lehew fine sandy loam, hilly phase, is variable. Most of it is cleared. A part is used for corn and hay but much is idle or abandoned. Improved farming practices are not generally used, and yields are very low.

Management requirements.—Lehew fine sandy loam, hilly phase, is used and managed chiefly in the same way as the larger areas of associated soils. Where it occupies areas large enough to warrant the expense of fencing, the soil may be used profitably for pasture; and management requirements will be similar to those described for the Armuchee soils. Much of the soil, however, is in small areas

associated with nonagricultural soils, and such areas are apparently best suited to forest.

Lehew fine sandy loam, steep phase.—This shallow sandy soil is on narrow sharp-crested steep comby ridges and on crests of mountains underlain by purple and red interbedded sandstone and shale. The parent materials were weathered from red, purple, and green thin-bedded acid shale and sandstone and from purple and yellow thin-bedded slightly calcareous shale and sandstone. The soil was developed under a mixed forest of hardwood and pine. Slopes range from 30 to 60 percent—the greater part of the soil having slopes near the upper limit of the range. Surface drainage is very rapid and internal drainage rapid.

Long continuous strips of this soil are on Log and Lone Mountains and on Big, Bluebird, Pinnacle, Pine, Bullrun, and Comb Ridges. It is associated with Montevallo or Muskingum soils in the uplands and Leadvale and Philo soils in the colluvial lands and bottom lands.

The soil is strongly acid but is generally less so than the Muskingum and Montevallo soils. Moisture conditions are relatively poor because of the rapid runoff and low water-holding capacity. Though it does not have a definitely developed profile, the following one is representative:

- 0 to 8 inches, pinkish-gray or light purplish-brown loose fine sandy loam.
- 8 to 30 inches, purplish-red fine sandy loam mixed with partly weathered red, purple, and green shale and sandstone fragments.
- 30 inches +, red and purple thin-bedded sandstone and shale.

Purple or red sandstone fragments are on the surface and in the soil. The sandstone outcrops in some places near the crests of the ridges.

The soil includes several variations. Where the land is cleared a large part of the original surface soil is missing and the upper part of the subsoil is the present plow layer. In some places the soil is similar to those of the Muskingum series and has a dominantly brownish-yellow or yellow subsoil. Because these areas are mingled with the normal soil in a complex pattern, it was not practical to delineate them on the soil map. A few areas have slopes of 70 percent or more. The variations are nowhere of sufficient extent or magnitude to alter materially the use suitability or management requirements of the soil.

Present use and management.—About 15 percent of Lehew fine sandy loam, steep phase, is cleared; the remaining 85 percent is in forest. The cleared land is used for corn, hay, and pasture. Corn is grown 1 or 2 years, and the soil then lies idle for several years. During the idle period various scrubby trees, broomsedge, and wild grasses become established. The fields are sometimes pastured but generally are not used. Where hay is grown, lespedeza is the chief crop. Fertilizer and other amendments ordinarily are not used, and crop yields are very low. All of the forested part has been logged, and the present forest is mainly small second-growth and cull trees. Shortleaf pine is the dominant species, but there are some hardwoods, chiefly oak. Except in the Norris Reservation, special methods of forest management usually are not used (pl. 2, C).

The soil is not suited to either crops or pasture because of its steep slope, shallowness, stoniness, and unfavorable moisture conditions.

It is best used for forest. Forested areas should remain in forest, and most of the cleared areas should be reforested. The forestry management requirements of this phase are similar to those of other shallow soils with steep slopes.

Limestone rockland (rolling).—This land type is on gently rolling to strongly rolling valley uplands underlain by tilted limestone (pl. 3), which is chiefly high grade or slightly clayey, but to a lesser extent, is slightly or moderately cherty. The original forest consisted chiefly of redcedar, although there were smaller numbers of hardwoods, including post oak, black gum, persimmon, and other trees adapted to poor moisture conditions. The extreme slope range is 2 to 30 percent, but most of the land has slopes of 5 to 16 percent. Surface runoff is rather rapid on all but the mildest slopes. Internal drainage is moderate. This land is in all the limestone valleys, chiefly in association with Talbott, Dewey, Fullerton, and Caylor soils, but also with rolling stony land (Talbott soil material).

This land type differs from the associated Rolling stony land (Talbott soil material) both in the extent and kind of outcrops. The outcrops on Rolling stony land (Talbott soil material) cover half or less of the land surface in most places, are generally low and relatively narrow, and are separated by fairly wide strips of soil material. In contrast, the outcrops on this land type cover well over half of the land area, protrude above the surface in large masses, and are separated by narrow strips of soil material.

The type of soil material also differs—that on the stony land resembling Talbott soils, and that on this land type, the Colbert soils. Usually this soil material is almost black or dark-brown heavy silty clay, a few inches to 1 to 2 feet thick, that is high in organic matter. Even though shallow over limestone bedrock, this material is acid because the cracks and crevices in the underlying rock allow free movement of water, and leaching proceeds at practically the same rate as in normal soils. The moderately rapid surface runoff and the shallow soil material, with its low absorptive capacity, make moisture conditions very poor for plant growth. Aside from the relatively wide range of slopes and local differences in the extent and kind of outcrops, this land type includes no significant variations.

Present use and management.—Practically all of Limestone rockland (rolling) is in forests of redcedar. A few more drought-resistant hardwoods are in some of the more favorable sites. Some of the less rocky land is partly cleared and used for pasture. On the better sites pastures of fair quality are obtained early in spring and late in fall, but they are very poor the rest of the year.

Management requirements.—Limestone rockland (rolling) requires variable use and management, depending upon the amount of outcrop, the area of the land type on any given farm, the kind and extent of other soils on farms, and various other factors. In general the land has so many unfavorable properties that it is not suitable for either crops or pasture, and it is therefore limited to forest use, even though the kinds of trees and yields of timber are much poorer than on most other land types and soils. The prevention of forest fires and the removal of weed trees that might compete with the more desirable species for the limited supplies of moisture and plant nutrients are the chief management requirements.

Under certain conditions it is more practical to use some of the more level, less rocky sites for pasture. Since intensive practices will not be profitable, the land should be left as nearly as possible in its natural condition. Removal of most of the trees and seeding to suitable pasture plants are probably the only special practices that can be feasibly used on the best sites; whereas on others, clearing the land may be the only advisable step.

Limestone rockland (rough).—This land type occurs on steep slopes and bluffs or escarpments along the larger streams of the limestone valleys. The underlying rocks are chiefly cherty dolomite or dolomitic limestone, although in some places they are high-grade limestone. Large limestone outcrops and large boulders cover much of the land surface in most places. The land was originally covered with a thin forest stand of redcedar, pine, and some of the more drought-resistant hardwoods, including such trees as post oak, black-jack oak, and blackgum. Slopes range from 30 to 60 percent or more, and much of the land has slopes near the upper limit of the range. Surface runoff is very rapid.

The largest area of this soil is on bluffs along the Powell River, where it is associated with Limestone rockland (rolling) and Rough stony land (Talbot soil material). Small areas are along some of the streams in the limestone valleys and the cherty ridge area.

This land differs from Limestone rockland (rolling) in several respects. It is on steeper slopes, the proportion of outcrops is greater, and the outcrops themselves are generally larger. The rock is chiefly cherty dolomite rather than high-grade limestone, and the small areas of soil material more nearly resemble that of Clarksville and Fullerton soils than of the Colbert. This land type differs from Rough stony land (Talbot soil material) chiefly in having more numerous and more rugged rock outcrops and generally steeper slopes. Moisture conditions and other factors affecting plant growth are unfavorable.

Present use and management.—Practically all of Limestone rockland (rough) is now in forest consisting of redcedar and small stunted hardwoods. Most of these trees have little value as timber, and in many places they are inaccessible and difficult or impossible to harvest. Rockiness and steep or precipitous slopes make this land unfit for anything except forest.

Management requirements.—Apparently special forestry management practices cannot be profitably used on Limestone rockland (rough). Forest fires should be prevented to protect adjoining forests on better lands and to preserve these stands, as they have some value in checking excessive runoff from the steep slopes, and thereby help prevent erosion or deposition on the adjoining lowland areas.

Lindside silt loam.—This is moderately fertile soil with a brown surface layer and a gray subsoil. It occurs on nearly level imperfectly drained bottoms along small streams and is physically fair to good cropland. The parent material is derived chiefly from alluvium washed from uplands underlain by limestone. A part of the soil, however, is derived from dolomitic material, and locally shale and sandstone may have contributed to its formation. This soil type has developed under a hardwood forest including oak, maple, beech,

and sweetgum. Slopes are less than 3 percent. Surface and internal drainage are slow.

The soil is chiefly in long narrow strips along the streams that drain Powell and Big Valleys and along Flat, Buffalo, and Hogskin Creeks. It is associated with Emory, Capshaw, and Talbott soils and with Rolling and Smooth stony lands (Talbott soil material). This type is also in small bodies along some of the larger streams in the cherty ridge area, where it is associated with Roane silt loam on the bottom lands, Greendale soils on the colluvial lands, and chiefly Clarksville and Fullerton soils in the adjoining uplands.

The following description is representative of much of Lindside silt loam:

- 0 to 12 inches, grayish-brown or brown friable heavy silt loam.
- 12 to 24 inches, grayish-brown or brownish-gray friable silt loam or light silty clay loam splotched with gray, yellow, and brown.
- 24 inches +, gray silt loam that may contain layers and lenses of sand and gravel.

Limestone or cherty dolomite bedrock is at depths of 3 to 10 feet or more.

The soil is slightly to medium acid. Its content of organic matter is low to medium but generally higher than in soils of the adjoining uplands. Good tilth is moderately easy to maintain, although the soil becomes cloddy or puddled if tilled when too wet. Unfavorable moisture conditions may seriously impede tillage operations during wet seasons, and the variety of crops that can be grown is definitely limited by the imperfect drainage.

The chief variations in the soil are in the thickness of the surface and other layers. The soil along streams in the cherty ridge area is somewhat lighter in texture and has a small quantity of chert in the surface layer and a relatively large quantity in the underlying alluvium. One or two small areas of a well-drained brown soil are included as well as a few small areas of dark (almost black) soil.

Present use and management.—Though practices vary from place to place, use and management of Lindside silt loam generally are not well adjusted to the physical properties of the soil. Practically all of the land is cleared, and about 40 percent is used for corn. Most of the rest is in hay and pasture, but small areas are used for small grains and various other crops. Practically no lime, fertilizer, or other soil amendments are applied. In a few places open ditches are used to remove excess surface water. Under current practices of management corn yields about 35 bushels an acre; lespedeza, 1.3 tons; and timothy and clover, 1.2 tons.

Management requirements.—Although the kinds of crops that can be grown are limited, the requirements for good management of Lindside silt loam are comparatively simple. Corn, soybeans, lespedeza, redbud, alsike clover, and red clover do fairly well; but the soil is not well suited to burley tobacco, alfalfa, barley, oats, and other crops that have deep root systems or require good drainage. The soil can be used continuously for row crops without being seriously injured, but short rotations are generally more practical from the standpoint of good farm management.

Winter cover crops are effective in preventing scouring or washing of the soil by overflow waters and are a source of humus and nitrogen when plowed under in spring. Where such a practice is followed,

corn and other crops may not require additional nitrogen, but applications of phosphorus and possibly potash will probably give profitable increases in yields. Small or medium applications of lime may be necessary to obtain good stands of legumes, but some of the soil may be fairly well supplied. Surface drainage can be improved by the use of open ditches. Tile drains may be useful in some places, but they should not be constructed without careful planning.

Montevallo shaly silt loam, rolling phase.—This shallow infertile severely eroded shaly soil is on the slopes of knobs and benches underlain by acid shale. It was formed under a mixed forest of oak, blackgum, hickory, and shortleaf pine. Slopes range from 5 to 15 percent. Both surface and internal drainage are rapid.

The soil is in the southwestern part of Texas Valley and in the eastern part of Little Valley. Most of it is small- or medium-sized areas on the lower slopes and benches. Montevallo shaly silt loam, steep phase, and Lehew soils are on adjoining uplands. Leadvale and Philo soils are on the adjacent colluvial and bottom lands.

The profile is similar to that of Montevallo shaly silt loam, steep phase, but a greater part of the upper layers has been removed by erosion because of more intensive use. In more severely eroded areas the shale bedrock is exposed at the surface in many places. The soil is very low in organic matter, extremely acid in most places, and very low in phosphorus and nitrogen. Moisture conditions for plant growth are very poor because of the large losses of water in runoff and the low water-holding capacity of the soil.

The soil varies in several respects. On the lower slopes of some hills the underlying rock contains thin beds of shaly limestone, and the soil resembles those of the Litz series. A few small areas have slopes of less than 5 percent. None of the variations are extensive enough to alter significantly the use suitability of the soil.

Present use and management.—Although practically all of Montevallo shaly silt loam, rolling phase, is cleared, its use is very poorly adjusted to its physical characteristics. Most of it has been cultivated at some time. Much of the soil is now abandoned; but some is used for corn, hay, and pasture. Common lespedeza is grown by a few farmers, but hay and pasture are largely a mixture of broomsedge and other volunteer or wild grasses. Fertilizer and other amendments are not ordinarily used on either crops or pasture. Yields are very low. After the land has been used a few years for crops or pasture under common management, yields become so low that the soil is abandoned. Some of the more severely eroded abandoned fields are devoid of any kind of vegetation, but in most places they support thin stands of Virginia pine, persimmon, and broomsedge. Most of these fields are idle, but a few farmers use them for grazing purposes.

Management requirements.—In general, conditions for plant growth are so poor in Montevallo shaly silt loam, rolling phase, that it is not suited for either crops or pasture. Although some areas that contain small quantities of limestone material in the underlying rock are normally somewhat more fertile, they were so poorly managed in the past that they are now severely eroded, and their productivity is very low. The soil is best used for forest.

Montevallo shaly silt loam, steep phase.—This shallow strongly acid soil is on the steep slopes of cone-shaped knobs and hills bordering

shale valleys. It was developed from parent material weathered from acid fissile shale. The extreme slope range is 15 to 60 percent, but about three-fourths of the soil has slopes in excess of 30 percent. Both surface and internal drainage are very rapid.

This phase is on the ridges, hills, and knobs in Texas, Hinds, Little, Buffalo, and Potato Valleys, associated chiefly with the rolling phase of Montevallo shaly silt loam and Lehew soils in the uplands and with Leadvale soils and Philo fine sandy loam in the adjoining colluvial lands and bottom lands.

Following is a profile description representative of much of this soil:

0 to 4 inches, light brownish-gray or yellowish-gray loose shaly silt loam.

4 to 18 inches, yellowish-brown silt loam mixed with partly weathered red, green, purple, yellow, and gray shale fragments.

18 inches +, variegated red, green, purple, yellow, and gray acid fissile shale.

This soil is very strongly acid and very low in organic matter. Moisture conditions for plant growth are poor because the soil has low moisture-absorbing and retaining properties and much water runs off the steep slopes. Where the soil is severely eroded all the upper layers may be missing, and shale bedrock is therefore exposed at the surface. In such places conditions for the growth of any kind of vegetation are extremely poor.

The chief variations included are those due to the degree of erosion and the color of the underlying shale. In some places the underlying rock contains a few thin lenses and beds of limestone. In such places the soil may be somewhat more fertile than normal, but the difference is usually not great enough to alter the physical use suitability. These areas resemble the Litz soils.

Present use and management.—Montevallo shaly silt loam, steep phase, is used and managed in a manner poorly adjusted to its physical properties. Practically all of the soil has been cleared and used for crops at some time. Its natural fertility was soon exhausted, and most of the soil became severely eroded after a few years. Most of it is now abandoned. Thin stands of shortleaf or Virginia pine are on many of the old fields and broomsedge and brush on others. On some of the more severely eroded areas, vegetation of any kind is sparse.

In some places the soil is used for corn and lespedeza. Fertilizer and other amendments are not ordinarily used. Yields are generally very low, and they become successively lower wherever the soil is used for crops from year to year. Forests are poorly managed. No attempts are made to control grazing or to prevent fires. In many places trees are cut as soon as they are large enough to yield one small plank. No practices to maintain or improve the forest stand are used.

Management requirements.—Because of its eroded condition, steep slopes, low fertility, extreme acidity, and poor moisture conditions, Montevallo shaly silt loam, steep phase, is not suited to crops or pasture. It is best suited to forest, although both the quantity and quality of timber are comparatively low. Areas now cleared should be reforested in order to stabilize the soil and prevent further erosion. A forest cover will prevent overwash that damages adjoining colluvial and bottom lands and also insure some future revenue from this soil. Some preparation of the soil may be necessary before trees can be successfully planted. Gullies can be controlled by check dams, and phos-

phate fertilizer may be beneficial. Varieties of pine are apparently best suited, although hardwoods may do fairly well on some of the more favorable sites. After trees are planted they should be protected from fire and grazing. Some measures for control of insect pests and diseases may also be required. Undesirable and mature trees should be removed, as a continued crop income from the forest can be obtained only by such systematic methods of harvesting.

Muskingum stony fine sandy loam, hilly deep phase.—This is a stony soil on the hilly slopes of mountains underlain chiefly by sandstone. It is much like Muskingum stony fine sandy loam, steep phase, but is on milder slopes. The soil includes variations comparable to those of the steep phase, and it was developed from similar parent material under the same kind of forest. Moisture conditions are possibly slightly more favorable because of the milder slopes (15 to 30 percent), but both surface and internal drainage are rapid.

This phase occurs in small areas on the foot slopes of the Cumberland Mountains in association with the steep phase of Muskingum stony fine sandy loam, and Jefferson, Pope, Philo soils, and Alluvial soils, undifferentiated. Moderately large areas are on Big Ridge and Clinch Mountain.

Following is a representative profile:

0 to 8 inches, yellowish-gray or brownish-gray loose fine sandy loam.

8 to 30 inches, brownish-yellow friable fine sandy clay loam spotted in lower part with red, brown, and gray.

The soil varies in several respects. Most of the surface soil is missing, and the subsoil is at the surface in most cleared areas. The proportion of shale in the parent material is variable. In places where the shale content is high, the soil is finer textured; and some areas having a silt loam surface soil are included. Small areas of soil with a red subsoil, resembling that of the Hector soils, are also included with this separation.

Present use and management.—Most of Muskingum stony fine sandy loam, hilly deep phase, is cleared, but land use and management are poorly adjusted to its physical properties. It is used for corn, hay, and pasture. Ordinarily, no improved management practices are used. Crops are not rotated, fertilizer and other amendments are not used, and no attempt is made to control runoff and prevent erosion. Yields are very low and become progressively lower under prevailing systems of management. When the low natural fertility is exhausted the soil is abandoned. In the most severely eroded areas the abandoned soil has little vegetation of any kind; but in other places broomsedge and brush soon become established. Virginia pine eventually covers most of the abandoned areas. Where the soil is in forest, it is managed in the same manner as the steep phase.

Management requirements.—Although moisture conditions in Muskingum stony fine sandy loam, hilly deep phase, are slightly better than in the steep phase, the soil is not suited to crops or pasture because of its strong slopes, stoniness, shallowness over bedrock, and low inherent fertility. It is therefore best suited to forest. Its forest management requirements are essentially the same as those of the steep phase.

Muskingum stony fine sandy loam, steep phase.—This shallow light-colored soil is on steep mountain slopes underlain by acid sandstone, conglomerate, and shale. It developed under a mixed hardwood

forest of oak, hickory, chestnut, and tuliptree. In the Cumberland Mountains there were some linden, beech, maple, and walnut on the lower slopes where moisture conditions were more favorable, and on the more droughty sites, shortleaf and Virginia pine. Slopes range from 30 to 60 percent, but are usually from 40 to 45 percent. Both surface and internal drainage are rapid.

Large almost continuous areas of this soil are on the Cumberland Mountain escarpment, on Big Ridge, and on Clinch Mountain associated chiefly with Muskingum stony fine sandy loam, hilly deep phase, and Lehigh soils. Pope, Philo, and Alluvial soils, undifferentiated, are on the adjoining bottom lands, and Jefferson stony fine sandy loam, rolling phase, is on the colluvial lands.

The soil is very strongly acid and low in organic matter. Roots and air move freely through it, but moisture conditions are only fair because of the open porous nature of the soil and the steep slopes. As in shallow soils, the profile is not well developed, but the one described as follows is representative:

0 to 8 inches, yellowish-gray or brownish-gray loose stony fine sandy loam.

8 to 20 inches, brownish-yellow friable stony fine sandy clay loam splotched in the lower part with red, brown, and gray.

Loose sandstone fragments and large boulders are on the surface and in the soil. Massive sandstone or conglomerate bedrock, which may contain some shale layers in places, is at a depth of 18 to 36 inches. The rock floor is uneven, and there are outcrops and ledges in many places.

The phase varies in several respects. In cleared areas most of the original surface soil is missing and the subsoil is now at the surface. A few small areas having a red subsoil are included, and they resemble the Hector soils. Small- or medium-sized areas of Muskingum stony fine sandy loam, hilly deep phase, are included because the heavy forest growth and rough lay of the land made close traverse of much of the area impractical. None of these variations are of sufficient importance or extent to alter materially the use suitability or management of the soil.

Present use and management.—Probably more than 95 percent of Muskingum stony fine sandy loam, steep phase, is in forest, but a small acreage is cleared and used for corn and pasture. Yields are usually very low, even on newly cleared areas. The low inherent fertility is soon exhausted, and the soil is abandoned after a few years.

Forest management practices are variable. Much of the soil is owned in relatively small tracts. All the first-class timber has been cut, and merchantable trees are harvested as soon as they mature. The present stands, poor both in quantity and quality, contain a relatively large proportion of small and cull trees of the less useful species. Much of the present timber is injured by fire, as few precautions for fire control are used.

Management requirements.—Inasmuch as Muskingum stony fine sandy loam, steep phase, is not suited to crops or pasture because of its steep slopes, low inherent fertility, stoniness, and poor moisture conditions, it is best used for forest. Its management requirements are therefore concerned chiefly with the conservation and use of forests. In general, the soil can be more advantageously used and managed where it is in large tracts under single ownership rather than in small

tracts; but many economic, sociological, and other factors bear upon the problem, and these must be considered before definite recommendations can be made for specific areas.

Ooltewah silt loam.—This imperfectly drained soil occurs in the bottoms of small shallow lime sinks in the limestone valleys. It has a brown surface layer and a gray subsoil, is moderately fertile, and is physically fair to good cropland. Parent materials were derived from local alluvium and colluvium, chiefly from Dewey and Talbott soils, but material from Fullerton and Clarksville soils are present in some places. The soil was originally covered by a hardwood forest of oak, hickory, maple, and willow. Slopes range from less than 1 to about 3 percent. There is practically no surface drainage because the soil is in depressions without outlets, and internal drainage is moderately slow.

Most of the soil is in small circular or elliptical areas in the small depressions of the limestone valleys. Dewey and Talbott soils and Rolling stony land (Talbott soil material) are on the adjoining uplands. A few areas are in lime sinks in the cherty ridges associated chiefly with Clarksville and Fullerton soils.

The following is a representative profile:

0 to 16 inches, light-brown or grayish-brown friable silt loam or heavy silt loam.

16 inches +, gray silty clay loam or light silty clay loam mottled with gray, yellow, and brown; material becomes lighter in color and heavier in texture with increasing depth.

Most of the soil is free of stone or chert, but in some places chert and small limestone fragments are present in small quantities on the surface and in the upper part of the soil. Limestone residuum or bedrock is at depths of a few to many feet.

The soil is medium acid. It contains low to moderate supplies of organic matter, but generally more than the soils of the surrounding uplands. Moisture conditions are only fair because the soil may be covered or saturated with water for several days after heavy rains. The soil is cold and wet in spring, and the planting of crops is delayed for this reason. Good tilth is moderately difficult to maintain because the adverse moisture conditions may necessitate tillage of the soil when too wet, and this practice may result in puddling or clodding.

The soil includes several variations. The brown surface layer is as little as 8 inches thick in some places and more than 30 inches in others. In some areas this layer appears to be a very recent accumulation of material that covers what was originally a poorly drained soil. A few small areas having heavy silty clay loam surface soil and a few bodies of poorly drained soil are also included. None of these variations are of sufficient importance to affect materially the use suitability or management requirements of the soils.

Present use and management.—All of Ooltewah silt loam is cleared and cultivated, and use and management are fairly well adjusted to the soil. Corn, lespedeza, red clover, and timothy are the chief crops; but small acreages are used for garden vegetables and burley tobacco, and some of the soil is in bluegrass and white clover pasture.

Crops are not systematically rotated. Row crops are grown for several years and then followed by several years of hay. Small quantities of fertilizer are used on wheat and corn. Tobacco is fertilized

heavily, but hay crops ordinarily receive no fertilizer. Little of the soil is ever limed. No special practices for controlling water are used. Some of the smaller areas are in fields with Talbott or Dewey soils and are managed in the same way as those adjoining upland soils.

Under common practices of management corn yields about 35 bushels an acre; wheat, 10 bushels; timothy and clover, 1.2 tons; and lespedeza, 1.3 tons.

Management requirements.—Although moisture conditions in Ooltewah silt loam are not ideal, the soil is suited to intensive use because of moderate fertility and gentle slopes. Its management requirements are relatively simple. The better drained areas are suited to corn, small grains, and most hay crops except alfalfa. Burley tobacco can be expected to do fairly well in normal seasons. The crops that can be grown on the more poorly drained areas are more limited. Corn, soybeans, and certain hay and pasture crops, including lespedeza, crimson clover, white clover, and bluegrass, are among the crops best suited to the soil.

Short rotations can be used, but they should include a legume. If turned under, the legume is effective in increasing the nitrogen and humus contents of the soil and in improving its friability and permeability. Lime in moderate quantities and at moderate intervals is required. All crops need phosphorus and potash. In general, fertilizer should be applied to meet the needs of the individual crops, rather than in large quantities at long intervals. To prevent puddling and clodding, which injure tilth and moisture conditions, avoid tillage of the soil when it is too wet.

Although artificial drainage would undoubtedly improve the soil, very little is done. It is therefore necessary to use the land only for crops suited to imperfect drainage conditions and to control moisture conditions as much as possible by tillage and cultural methods.

Philo fine sandy loam.—This sandy loam occurs on nearly level imperfectly drained bottom lands underlain by young stream alluvium (pl. 4, A). It is a relatively infertile acid soil with a brownish surface layer and a gray subsoil and is physically fair cropland. The parent material consists of alluvium washed from uplands underlain by sandstone and shale. The soil was formed under a mixed forest of beech, maple, elm, oak, sycamore, birch, willow, and hemlock. Slopes are less than 3 percent. The soil is subject to overflow, and both surface and internal drainage are slow.

Long narrow strips of this soil are along Bullrun, Hinds, Crooked, and Fall Creeks and along the small creeks at the foot of the Cumberland Mountains. They are associated with Pope soils of the bottom lands and with Muskingum, Montevallo, and Lehew soils of the adjacent uplands.

This soil differs from Pope fine sandy loam chiefly in being less well drained and from the Linside soils in being derived mainly from sandstone and shale materials rather than limestone. It is a young soil and has a weakly developed profile as follows:

- 0 to 10 inches, brownish-gray to grayish-brown friable fine sandy loam.
- 10 to 30 inches, brownish-gray to gray friable fine sandy loam or fine sandy clay loam splotched with yellow and brown.
- 30 inches +, beds of sand with gravelly and silty layers in places; is underlain at depths of 6 to 10 feet or more by bedrock.

The soil has a low to medium supply of organic matter, but generally more than the soils of the adjoining uplands. It is strongly to very strongly acid. Though permeable to moisture, it becomes saturated with water during wet seasons because of slow surface runoff and slow internal drainage. Good tilth is fairly easy to maintain in all except the parts having heavier surface soil. Those become puddled or cloddy if tilled when too wet.

The soil includes several variations. The most important one is in the shale valleys where most of the soil has a silt loam surface layer, a silty clay loam subsoil, and silty underlying alluvium washed largely from shale. In places in these valleys the soil has a purplish cast because of the content of materials from purple shale.

Present use and management.—The use of Philo fine sandy loam is fairly well adjusted to its physical properties, but management practices for improving the soil or compensating for its deficiencies are not used. Practically all the soil is cleared. It is used chiefly for corn and hay, but small acreages are idle. No system of rotating crops is used; and ordinarily no lime, fertilizer, or other soil amendments are applied. Under current systems of management, yields of about 20 bushels of corn and 0.7 ton of lespedeza or mixed hay an acre are expected.

Management requirements.—Good management of Philo fine sandy loam is comparatively simple, but imperfect drainage limits the variety of crops that can be grown. Corn, soybeans, sorghum, vegetables, alsike clover, redtop, lespedeza, white clover, and bluegrass can be expected to do fairly well; but the soil is not well suited to alfalfa, oats, barley, and burley tobacco. Winter cover crops are needed, as they protect the soil from washing and provide humus and nitrogen when plowed under in spring.

A short rotation of corn, wheat, and hay should be fairly well suited to the better drained areas, but corn and hay can be grown in alternate years. All crops need fertilizer containing phosphorus and potash, and all except the legumes or legume-grass mixtures require some nitrogen. Liming is necessary to insure success with legumes. Surface drainage can be improved by the use of small open ditches, but tile drains may not be of practical value because of high cost.

Under good management corn yields about 35 bushels an acre; timothy and clover, 1.1 tons; and lespedeza, 1 ton.

Pope fine sandy loam.—This type occurs on nearly level well-drained bottom lands and differs from the closely associated Philo fine sandy loam chiefly in being better drained. It is a grayish-brown acid sandy soil of low to moderate fertility and is physically fair to good cropland. The parent material consists of young stream alluvium washed largely from uplands underlain mainly by sandstone and, to a lesser degree, by shale. Locally, small quantities of limestone material may be included. The soil was developed under a forest of sycamore, beech, maple, birch, Carolina poplar, hemlock, and willow. It has slopes of less than 3 percent, and is subject to overflow, chiefly in spring. Both surface and internal drainage are moderate.

This type is in several large areas along Cove and Bullrun Creeks, associated with Philo fine sandy loam on the bottom lands, and Muskingum, Lehew, or Montevallo soils on the adjoining uplands. The following describes a representative profile:

0 to 12 inches, grayish-brown friable fine sandy loam.

12 to 36 inches, light-brown or yellowish-brown friable fine sandy loam; lower part of layer may be faintly spotted with gray and brown.

36 inches +, alternating beds of sand, silt, and gravel.

Various kinds of bedrock are at depths of 10 feet or more in most places.

The soil is medium to strongly acid. The content of organic matter is relatively low in comparison with that in most soils but higher than that in soils on the surrounding uplands. This soil is subject to overflow in spring, but water circulates freely through the profile. Moisture conditions are generally favorable for plants, though crops on some of the lighter textured areas may be injured by droughts. Good tilth is easily maintained, and tillage can be accomplished over a wide range of moisture conditions.

The variations are chiefly in texture. That part of the soil in the shale valleys is chiefly silt loam. Where the streams flow through limestone areas a small quantity of limestone material is in the soil, and thin layers of local alluvium from limestone material are over the surface of the original soil.

Present use and management.—Most of Pope fine sandy loam is used for purposes to which it is well suited physically, but management practices are not designed to compensate for soil deficiencies. All the soil is cleared and cultivated. It is used chiefly for corn, but some is in hay, and small acreages are in vegetables. Corn is grown for many years in succession on much of the soil; but in some places several years of corn will be interspersed at intervals with hay crops, chiefly lespedeza. Lime and fertilizer are not used for any crop. Under prevailing systems of management corn yields about 30 bushels an acre; wheat, 10 bushels; lespedeza, 0.9 ton; or mixed hay, 1.3 tons.

Management requirements.—Good management of Pope fine sandy loam is relatively simple. The soil is suited to all of the crops commonly grown in the area, with the possible exception of burley tobacco and deep-rooted legumes, such as alfalfa. Some of the larger broader areas can be used in corn-small grain-hay rotations to advantage. Where necessary, however, row crops can be grown each year without seriously depleting the soil, provided cover crops are seeded in the fall and plowed under the following spring. Cover crops protect the soil from scouring by overflow waters, furnish nitrogen, and increase the content of humus.

All crops except legumes need fertilizer containing nitrogen, phosphorus, and potassium. Legumes ordinarily require no nitrogen but need lime to insure good stands. In places trees or close-growing vegetation should be planted along the stream banks to prevent bank cutting and to check the velocity of overflow water.

Roane silt loam.—This moderately fertile brown soil has a cemented layer at variable depths, and it occupies nearly level or gently sloping well-drained narrow first-bottom lands along the small streams in the cherty ridge area. It is physically good cropland. The parent material consists of recent stream alluvium washed largely from uplands underlain by cherty dolomite. The soil was developed under a hardwood forest. Slopes are less than 3 percent. Surface drainage is moderate, but internal drainage may be somewhat slow because of the cemented layer.

The soil is in long narrow strips in all of the cherty ridge area. It is associated chiefly with Greendale soils on the adjacent colluvial lands and with various soils of the adjacent uplands underlain by cherty dolomite, or dolomitic limestone, mainly those of the Clarksville and Fullerton series.

The color and thickness of the various layers are variable, but the following profile description is representative of much of the soil:

- 0 to 10 inches, light-brown to grayish-brown friable silt loam.
- 10 to 24 inches, light-brown or yellowish-brown friable moderately cherty silt loam or light silty clay loam.
- 24 to 36 inches, compact or cemented fine chert and brown silt loam splotted with gray, red, and yellow.
- 36 inches +, cherty alluvium with some lenses and layers of sand and fine gravel.

Some fine chert fragments are on the surface and in the soil in most places. The alluvium, several feet thick in most places, is underlain by cherty dolomite bedrock.

The soil has a low to medium content of organic matter but generally more than have the associated soils of uplands and colluvial lands. It is medium acid to neutral in reaction. Moisture conditions are satisfactory for nearly all kinds of plants. The soil is subject to overflow but ordinarily is covered with water for only a few hours at a time and at infrequent intervals. Surface drainage is rapid enough to remove excess water in a short time.

The soil includes several variations. The areas along the smaller streams are not ordinarily subject to overflow. In other places the subsoil layer may be missing, and the surface layer rests directly on the cemented layer. In a few places there is a large quantity of angular chert fragments on the surface and in the soil. These variations are all of small or moderate extent and are not confined to any definite locality.

Present use and management.—All of Roane silt loam is cleared. About 25 percent is used for corn, 10 percent for burley tobacco, and 40 percent for hay. Most of the remaining 25 percent is in potatoes, vegetables, fruit, and wheat, but a small area is in pasture.

Use and management vary, but in general are fairly well adjusted to the physical properties of the soil. A few farmers use a rotation in which a row crop is followed by small grain seeded to hay, but much of the soil is used continuously for row crops, including corn, burley tobacco, and vegetables. Some of the better farmers use fertilizers in moderate or large quantities. A small part of the soil has been limed in recent years, but the quantities and frequency of application are not adjusted to the needs of the soil. No special practices for controlling water on the land are used.

Under prevailing systems of management corn yields about 28 bushels an acre; wheat, 10 bushels; burley tobacco, 1,000 pounds; and lespedeza, 1 ton.

Management requirements.—Roane silt loam is suited to intensive use, but good management requires the correct choice and rotation of crops and the use of lime, fertilizer, and other soil amendments. Corn, burley tobacco, vegetables, small grains, legumes with the possible exception of alfalfa, and various grasses can be expected to do well. Under careful management, the soil can be used for row crops each year. After the crop is harvested in the fall, a cover crop, such as

winter oats or crimson clover, can be used to protect the soil from washing during winter and to furnish nitrogen and increase the humus supply when it is plowed under in spring. Where practical a rotation of a row crop, small grain, and hay is well suited to the soil.

An adequate supply of lime is necessary to insure success with legumes; but the soil should be tested before lime is applied, because some areas have enough lime, and additional quantities will be wasted. All crops apparently need moderate to large applications of phosphorus and some potash, but where legumes and winter cover crops are used, very little additional nitrogen is required.

Under good management corn yields about 45 bushels an acre; wheat, 18 bushels; burley tobacco, 1,300 pounds; and lespedeza, 1.5 tons.

Rolling stony land (Talbot soil material).—This land type is on valley uplands underlain by tilted and folded high-grade limestone. As with Smooth stony land (Talbot soil material), this land is characterized by many limestone outcrops that prevent the use of the soil for crops. Under good management, however, it is fair to good pasture land. The original cover was a mixed forest of oak, hickory, maple, walnut, and redcedar. Slopes range from 7 to 30 percent. The land surface is very irregular in conformation because of the large number of lime sinks. Surface drainage is moderate, and internal drainage is adequate even though bedrock is at shallow depths, because fissures in the folded and broken rock allow free movement of water.

This land type is in all the limestone valleys associated with Smooth stony land (Talbot soil material) and soils of the Dewey, Caylor, and Talbot series. Ooltewah silt loam is in the bottoms of some of the larger lime sinks. In the cherty ridge area relatively small bodies of this land type occur in association with soils of the Clarksville and Fullerton series.

Half or less of the surface area is limestone bedrock outcrops, and the spaces between are filled with heavy soil material a few inches to 2 or 3 feet thick. This material has properties similar to those of the Talbot soils. It is yellowish to reddish and ranges in texture from silty clay loam to silty clay. The organic-matter content is low. Although underlain at shallow depth by limestone bedrock, the soil material is strongly or very strongly acid. Moisture conditions for plant growth are good during periods of adequate rainfall, but are poor during droughts because the soil material is shallow over bedrock. In addition to the bedrock outcrops there are loose fragments of limestone over the land in many places.

The relatively wide range of slopes and the different kinds of underlying rock are the chief variations. Possibly one-fourth of the land type is in the cherty ridge area. There, the outcrops are of cherty dolomite, and the soil material resembles that of the Fullerton soils. Much of this part of the land has slopes near the upper limit of the range, and moisture conditions and other factors are less favorable for plant growth than on the typical land of the limestone valleys.

Present use and management.—Most of Rolling stony land (Talbot soil material) is cleared or in cut-over forest. Practically all the cleared land is now used for pasture, but management practices vary widely. A few of the better farmers maintain high-quality bluegrass

and clover pasture by the use of lime and phosphate, eradication of weeds, and careful control of grazing. Most pastures, however, consist of a mixture of bluegrass, broomsedge, clover, and other herbaceous plants. Amendments are not used, and no attempt is made to remove weeds and brush. The number of grazing animals is not adjusted to the carrying capacity of the pastures during different seasons. Under such systems of management, pastures of good quality are obtained in spring and late in fall, but during the hot summer they are generally poor.

Management requirements.—Most of Rolling stony land (Talbot soil material) can be profitably used for pasture, although the steepest and stoniest areas are better suited to forest.

Applications of lime and phosphorus will increase the yield and quality of pasture, and in general these increases will be profitable. Where pastures are treated, the mixtures are largely bluegrass and white clover; and if these plants are properly grazed, few weeds will appear. If weed eradication is necessary, it can be accomplished with a mowing machine over many areas of the land type where the outcrops do not protrude far above the surface.

Even under good management the carrying capacity of pastures is greatly reduced during summer, and to prevent injuring the stands by overgrazing, temporary summer pasture should be provided elsewhere for part of the livestock. Thin shading by widely spaced locust or black walnut trees is beneficial to pastures, but other trees and brush should be removed. Under good conditions, such intensive management may not be profitable; and it may be necessary to use the land in its natural condition without special management practices.

Rough gullied land (Montevallo soil material).—Comprising this land type are areas of Montevallo soil so seriously eroded that the land surface is now a network of gullies. In most places practically all the original shallow soil and parent material has been removed, and gullies are now entrenched in the underlying soft acid shale. Slopes range from 8 to 30 percent, but are usually in the upper part of the range.

Small areas of this land are on the slopes of the shale knobs in the southeastern part of the area, where they are associated with Montevallo soils in the uplands, and with Leadvale and Philo soils in adjacent stream valleys.

Present use and management.—Practically all of Rough gullied land (Montevallo soil material) is abandoned. Much of it is devoid of any kind of vegetation, but in places there are thin stands of short-leaf or scrub pines and scant growths of broomsedge. In most places active accelerated erosion continues, and the adjoining less severely eroded soils are gradually being reduced to the condition of this land. At the same time the productivity of soils on adjoining colluvial lands and bottom lands is being impaired by accumulation of materials from this land type.

Management requirements.—Reclamation of Rough gullied land (Montevallo soil material) is even more difficult than that of Rough gullied land (Talbot soil material) because more of the original soil is gone and the remaining material is much less fertile. Soil and moisture conditions are so poor that only the more drought-resistant trees can be grown. Plantings of pine offer the best means of stabiliz-

ing this land, although check dams may be necessary in the larger more active gullies. After forests become established, they should be maintained by good forest management methods.

Rough gullied land (Talbot soil material).—Included in this land type are Talbot and Fullerton soils so severely eroded that the present land surface is largely a network of gullies. The underlying soil materials are chiefly red or yellowish-red cherty silty clay loam or silty clay. Slopes are from 7 to 30 percent or more, and over half of them are in the upper part of the range. Small areas occur throughout the cherty ridge area in association with Clarksville and Fullerton soils and in the limestone valleys associated with Talbot and Dewey soils.

Present use and management.—Practically all of Rough gullied land (Talbot soil material) is abandoned. A few areas have been reforested through the efforts of public agencies, but much of the acreage is covered with sparse growths of wild grasses and small volunteer trees, including scrub pine, persimmon, and oak. Part of the land is devoid of vegetation of any kind. This land has very little value to the owner on whose farm it is located. In fact, it is a liability in its present condition because the vegetation is not effective in checking active erosion, and the gullies will cut back and encroach upon adjacent uneroded uplands. Nearby colluvial and bottom lands will have their productivity reduced by the deposits of heavy subsoil material, which is low in fertility.

Management requirements. Reclamation of Rough gullied land (Talbot soil material) can be accomplished by the individual farmer only by extremely slow processes over an extended period of time. The specific practices needed will vary from farm to farm and from one area of the land to another. In many places it will be necessary to stabilize the larger gullies by the use of check dams. Forest trees are probably the best vegetation for controlling erosion when cost and effectiveness are considered. On this land, pine and black locust are probably the most useful kinds of trees. Better stands and more vigorous growth can be obtained if small or moderate quantities of phosphorus are applied when the trees are planted. Much of the land should be allowed to remain in forest permanently, once a stand is established.

Sericea lespedeza and kudzu are effective in reclaiming some of the smoother parts. After these plants are well established, they furnish some pasture for livestock; but on such land, grazing must be very carefully controlled to prevent injury to the stand.

Rough stony land (Fullerton soil material).—This type resembles Rolling stony land (Talbot soil material) in having many limestone outcrops but differs in having steeper slopes and therefore less favorable conditions for plant growth. These conditions are so unfavorable that the land is not suited to either crops or pasture and is best used for forest. It is chiefly on steep slopes and bluffs and is underlain by cherty dolomite along the larger streams and by high-grade limestone on the lower slopes of valley mountains.

The original forest cover consisted of oak, hickory, blackgum, sourwood, beech, and maple, with pine and cedar in the more droughty sites. Slopes range from 30 to 60 percent—the greater part of the



Limestone rockland (rolling) on rolling valley uplands underlain by tilted limestone in background; bedrock outcrops cover over half of the land area, and the soil material between the outcrops is very shallow. In most places, this land type is covered with a sparse growth of cedar.



- A, Sequatchie fine sandy loam in immediate foreground is being used for a short rotation, including tobacco; Philo fine sandy loam in center is used for a short rotation, including chiefly corn and lespedeza; forest on the steep or irregular ridges of Lelew soils in background.
- B, Farm buildings show the deterioration of an overworked and eroded area of Sequoia silty clay loam, eroded rolling phase.
- C, Corn on Sequoia silty clay loam, eroded rolling phase, in foreground; when properly managed, the soil is fairly productive and is adapted to most crops common to the area, including alfalfa, red clover, and tobacco.

land having slopes in the middle part of the range. Surface drainage is very rapid and internal drainage moderate.

The land type is chiefly in the cherty ridge area. Large tracts are on the steep slopes along the Powell and the Clinch Rivers and their tributaries. Small areas are on the short steep slopes along streams in the limestone valleys.

This land type differs from Rolling stony land (Talbot soil material) in other characteristics than slope. Most of the outcrops in this land protrude a foot or more above ground. Over much of the land, the underlying rock is cherty dolomite or dolomitic limestone. The soil material in the spaces between outcrops more nearly resembles the Fullerton than the Talbot soils. In most places it is strongly acid reddish cherty silty clay or silty clay loam a few inches to several feet thick. This soil material is low in organic matter and relatively low in plant nutrients. Moisture conditions are rather poor because of the shallow depth of the material and the large runoff on the steep slopes.

Present use and management.—Most of Rough stony land (Fullerton soil material) on the mountain slopes is used for pasture, and that in the cherty ridge area, for forest. In general, no special management practices are used on pastures. They consist of volunteer wild and tame plants, including large quantities of broomsedge and lesser ones of lespedeza, bluegrass, and white clover. The pastures furnish a moderate amount of fair grazing during spring and late in fall, but they are dry and of very poor quality during summer.

Management requirements.—On the mountain slopes much of Rough stony land (Fullerton soil material) apparently can be used for pasture. Its use on any individual farm can be determined by many factors, however, and among those considered are the acreage and distribution of this land on the farm, the proportions and kinds of other soils, and the physical use suitability of the land itself. Management requirements likewise vary. In some places it may be advisable to use few or no special practices, whereas in others the more intensive practices described for Rolling stony land (Talbot soil material) are applicable. Practically all the land in the cherty ridge area has so many unfavorable properties that it is not physically suited to either crops or pasture. It is best used for forest, and management requirements are those for forests.

Sequatchie fine sandy loam.—This moderately fertile brown sandy soil is on nearly level or gently sloping low terraces or second bottoms along rivers and larger streams of the area. It is fair to good cropland. The parent material is alluvium washed largely from uplands underlain by sandstone, but locally there may be some shale and limestone material. The soil was developed under hardwood forest. Slopes range from less than 2 to 10 percent—the greater area having slopes in the lower part of the range. Both surface and internal drainage are moderate.

Rather broad areas of this soil are along small streams that flow across Powell Valley. There it is associated in a complex pattern with soils of the colluvial lands, bottom lands, and uplands, including those of the Jefferson, Allen, Caylor, Lindsie, Philo, and Talbot series and Rolling stony land (Talbot soil material). Small

areas are along many of the streams, but the largest acreage is in Powell Valley.

Following is a profile description:

- 0 to 12 inches, light-brown or grayish-brown very friable fine sandy loam.
- 12 to 30 inches, yellowish-brown, brownish-yellow, or light reddish-brown friable fine sandy clay loam.
- 30 inches +, brownish-yellow sandy alluvium splotched with gray, yellow, and brown.

The alluvial material is generally underlain by limestone or cherty dolomite bedrock at depths of 6 to 10 feet or more.

The soil is medium to strongly acid and relatively low in organic matter. Good tilth is easily maintained, and tillage can be carried on over a fairly wide range of moisture conditions. Plant roots penetrate the soil readily; and air and moisture circulate freely. The moisture-holding properties are relatively poor, but the position of the soil is such that the supply of moisture is ordinarily adequate for growing plants.

This soil includes several variations. That part along small streams in Powell Valley is somewhat heavier in texture, browner in color, and more distinctly developed in profile than the rest. In this valley another variation of small extent includes areas in which the lower part of the subsoil is slightly compact or slightly cemented. Locally there may be small areas having a considerable quantity of angular sandstone fragments on the surface and in the upper part of the soil. In some places chert that has rolled down from the adjoining slopes is on the surface. None of these variations are of sufficient importance to alter significantly the use suitability or management requirements of the soil.

Present use and management.—Although use of Sequatchie fine sandy loam is fairly well adjusted to its physical properties, increased yields of crops can be obtained by improved management. All the soil is cleared and cultivated. It is used chiefly for corn, wheat, burley tobacco, and hay. Some of the soil in Powell Valley is used for pasture. Systematic rotation of crops is not generally practiced. Row crops and small grains are grown for several years and followed by a few years of hay. Tobacco receives moderate to large quantities of complete fertilizer, and small quantities are applied to corn and small grains. Hay crops are not ordinarily fertilized. Little of the soil is ever limed.

Under prevailing systems of management corn yields about 28 bushels an acre; wheat, 15 bushels; burley tobacco, 1,100 pounds; and lespedeza, 1 ton; or mixed hay, 1.2 tons. Where lime is used in addition to other common practices, alfalfa yields about 2.2 tons an acre.

Management requirements.—The proper selection and rotation of crops and the use of lime and fertilizer are the principal needs of Sequatchie fine sandy loam. The soil is suited to a wide variety of crops, including corn, burley tobacco, small grains, grass and legume hays, vegetables, and fruit. It can be conserved under short rotations including a row crop once in 2 or 3 years. A rotation of a row crop followed by a small grain, seeded to an annual legume, is well suited to the soil. Where it is practical to use longer rotations, alfalfa can be included. In any case, cover crops of either grasses

or legumes should be maintained during fall and winter. They prevent soil erosion, and when plowed under in spring, are effective in increasing supplies of humus and nitrogen.

Tobacco and vegetable crops need moderate to large quantities of complete fertilizer high in content of phosphorus and potash and low to medium in nitrogen. Small grains require similar fertilizer in smaller quantities, and with a smaller proportion of potash. Legumes, either alone or in grass mixtures, need phosphorus and probably potash, but no nitrogen. Grasses by themselves should receive a complete fertilizer. Lime applied in small or moderate quantities at rather frequent intervals is necessary to obtain good stands of legumes. Where crops are rotated and adequately fertilized, no special practices for controlling runoff are necessary.

Under good management corn yields about 45 bushels an acre; wheat, 22 bushels; burley tobacco, 1,400 pounds; lespedeza, 1.5 tons; and alfalfa, 3 tons.

Sequoia silt loam, undulating phase.—This soil is on well-drained uplands in low-lying valleys underlain by interbedded shale and limestone. The soil was developed under a mixed hardwood forest of oak, hickory, beech, and maple. It has grayish-brown surface soil and yellow subsoil. Slopes range from 2 to 7 percent. Surface drainage is moderate, but internal drainage is retarded slightly by the heavy subsoil. Most of the soil is in Raccoon Valley, but small acreages are in other shale valleys. It is in small areas associated chiefly with Armuchee soils.

The profile of this soil is similar to that of Talbott silt loam, but it has a lighter colored surface soil and subsoil and is not so heavy and compact in the subsoil. The following is a profile description:

- 0 to 10 inches, grayish-brown or brownish-gray friable silt loam.
- 10 to 30 inches, brownish-yellow to reddish-yellow moderately plastic silty clay loam with a well-developed nut structure.
- 30 inches +, brownish-yellow plastic silty clay splotched with gray, red, and light yellow.

The underlying bedrock consists of yellow shale and thin beds and lenses of gray or blue shaly limestone. This rock is at depths of 3 to 4 feet in most places, but thin ledges may outcrop on the surface.

The soil is low in organic matter and strongly acid. Air, moisture, and plant roots penetrate freely. Tillage can be accomplished without injury to tilth over only a relatively narrow range of moisture conditions. Where the soil is eroded, much of the original surface soil is missing, and the present surface layer is largely a mixture of the upper part of the subsoil and the remnants of the surface soil. In such places moisture conditions are less favorable and good tilth is maintained with difficulty.

The chief variations in this soil are those due to differences in erosion. In addition, the soil is associated in a complex pattern with other limestone and shale soils, and small areas of those soils are included in some places.

Present use and management.—Practically all Sequoia silt loam, undulating phase, is cleared and cultivated; and it is used for purposes to which it is at least fairly well suited. An estimated 30 percent is used for corn, 40 percent for hay and pasture, and 30 percent for small grain and miscellaneous field crops. Systematic crop rotations are

not generally followed. The kind of crop grown and the length of time it remains in a given field is determined by the immediate needs of the farmer. Some fertilization is practiced, but the amounts and frequencies of application are not adequate to produce high yields. Tobacco and vegetable crops receive fairly heavy applications of high-grade fertilizer.

Under common management corn yields about 25 bushels an acre; wheat, 10 bushels; burley tobacco, 1,000 pounds; and lespedeza, 0.8 ton.

Management requirements.—Sequoia silt loam, undulating phase, is not so exacting in management requirements as Sequoia silty clay loam, eroded rolling phase; but practices for improving tilth and moisture conditions, preventing erosion, and increasing the supplies of humus, lime, phosphorus, and potash are required. Apparently the soil can be conserved under a rotation including a row crop once in 3 to 4 years if other management requirements are met. It is fairly well suited to corn, burley tobacco, small grains, and some vegetable crops. Alfalfa and red clover do well when properly treated, and they increase the content of organic matter and humus, improve tilth of the surface soil, and prevent erosion.

Medium applications of lime at moderately frequent intervals are necessary to obtain good stands of legumes. Barnyard manure, besides increasing the nitrogen and humus content and furnishing some potash, will help control runoff by improving tilth and increasing the absorptive qualities of the soil. Liberal applications of phosphorus are required for all crops, including pasture; and potash is also needed. These materials are probably most economically furnished through high-analysis commercial fertilizer.

In general, runoff and soil moisture can best be controlled and conserved by proper choice and rotation of crops and proper use of amendments rather than by mechanical means. Cultivation should be on the contour, however; and broad-base terraces may be beneficial in some places. The terraces must be carefully planned, constructed, and maintained to be effective.

Under good management corn yields 38 bushels an acre; wheat, 16 bushels; burley tobacco, 1,200 pounds; and lespedeza, 1.2 tons.

Sequoia silty clay loam, eroded rolling phase.—This phase is in valleys underlain by interbedded limestone and shale. It has grayish-brown surface soil and yellow subsoil, and is fair to good cropland. The soil was developed under a mixed hardwood forest of oak, hickory, beech, and maple. There may have been shortleaf pine in some places. Slopes range from 7 to 15 percent. Surface drainage is moderate, but internal drainage is retarded slightly by the heavy subsoil.

Most of the soil is in Raccoon and Powell Valleys in small areas associated chiefly with Armuchee soils, but the soil pattern is very complex because of folding and faulting of the underlying rocks. Soils of the Talbott, Montevallo, and Fullerton series, and Rolling and Smooth stony lands (Talbott soil material) are on immediately adjacent uplands.

The profile of this soil is similar to that of Talbott silty clay loam, eroded rolling phase, but it has a lighter colored surface soil and subsoil, and is not so heavy and compact in the subsoil. It differs from

Sequoia silt loam, undulating phase, in being more eroded and in having stronger slopes. The following is a representative profile:

- 0 to 6 inches, grayish-brown to light yellowish-brown friable silty clay loam.
- 6 to 24 inches, reddish-yellow to brownish-yellow moderately plastic silty clay loam with a well-developed nut structure.
- 24 inches +, brownish-yellow plastic silty clay splotched with gray, red, and yellow.

The underlying rock is yellow or greenish-yellow shale containing thin beds and lenses of gray or blue shaly limestone. This rock is at depths of 3 to 4 feet in most places; but where the soil is severely eroded, thin ledges of limestone may outcrop on the surface.

The soil is low in organic matter and is strongly acid. Air, moisture, and plant roots move in it freely. Tillage can be accomplished without injury to tilth over only a relatively narrow range of moisture conditions. Where the soil is severely eroded much of the original surface soil is missing, and the present surface layer is largely the upper subsoil mixed with remnants of the surface soil. In such places moisture conditions are less favorable and good tilth is maintained with difficulty (pl. 4, *B*).

The chief variations included in mapping this soil are those caused by erosion. Because the soil is associated in a complex pattern with other limestone and shale soils, small areas of Montevallo and Talbott soils and Rolling stony land (Talbott soil material) may be included in some places.

Present use and management.—Practically all of Sequoia silty clay loam, eroded rolling phase, is cleared and cultivated. It is used for corn, burley tobacco, vegetables, and hay, and is fairly well suited to those crops, but no attempt is made to compensate for soil deficiencies. General management practices are much like those described for Talbott silty clay loam, eroded rolling phase. Under common practices of management, corn yields about 20 bushels an acre; wheat, 9 bushels; burley tobacco, 800 pounds; and lespedeza hay, 0.7 ton.

Management requirements.—Good management of Sequoia silty clay loam, eroded rolling phase (pl. 4, *C*), is similar to that for Talbott silty clay loam, eroded rolling phase, and similar practices are applicable. Under good management corn yields 30 bushels an acre; wheat, 14 bushels; burley tobacco, 1,000 pounds; and lespedeza hay, 1 ton.

Smooth stony land (Talbott soil material).—Outcroppings of limestone bedrock numerous enough to prevent tillage are characteristic of this land. The soil is on nearly level or gently sloping uplands in limestone valleys and is underlain by relatively high-grade limestone. The original vegetation was a hardwood forest of oak, hickory, maple, walnut, and considerable redcedar. Slopes range from nearly level to 7 percent. Surface drainage is moderate, but internal drainage may be somewhat slow because of the shallow depth to bedrock and the heavy soil material.

This land type is in rather broad areas in Powell Valley, Big Valley, and Flat Creek. It is associated chiefly with Rolling stony land (Talbott soil material) and Talbott, Colbert, and Dewey soils.

The land consists of alternate strips of limestone bedrock and heavy limestone soil materials. The outcrops protrude above the surface

only a few inches in most places and cover as much as half of the surface over much of the area. The soil materials are a few inches to 2 or 3 feet thick. They are chiefly silty clays similar in properties to the subsoils of the Talbott soils and are generally acid. They are relatively low in organic matter and in mineral plant nutrients. Moisture conditions are favorable for the growth of grasses in all except the periods of low rainfall, during which moisture in the shallow soil materials becomes depleted.

Present use and management.—Most of Smooth stony land (Talbott soil material) is cleared. It is used almost entirely for pasture, but a small acreage is in hay and corn. Pastures consist almost entirely of volunteer or wild grasses, including bluegrass, white clover, lespedeza, and broomsedge. Few special practices for improving pastures are used, but most farmers make some attempt to keep down brush and weeds. The yields of corn are very low, but the land is fairly productive of pastures under current management.

Management requirements.—Because of the large quantity of bedrock outcrop and the shallowness of the soil, this land is not suited to crops; but under good management, is good grazing land. Management requirements are concerned with selecting proper pasture mixtures and providing proper amendments for them. The land is well suited to bluegrass and white clover, but lespedeza, other clovers, and grasses can be expected to do well. Small or moderate applications of phosphate and lime will increase both the quantity and quality of the stand.

Over much of this land, weeds and brush can be controlled by clipping with a mower, because the outcrops do not protrude far enough above the surface to interfere with mowing. Grazing should be carefully controlled during dry periods to prevent injury to the pasture. Widely spaced locust or walnut trees are beneficial.

Talbott silt loam, undulating phase.—Because it is on milder slopes than Talbott silty clay loam, eroded rolling phase, this soil is less severely eroded and less susceptible to further erosion. It has a thicker surface soil, generally better tilth, better moisture conditions, and a larger supply of humus and mineral plant nutrients. Physically it is fair to good cropland. The soil is on undulating uplands in the limestone valleys and has slopes of 2 to 7 percent. Surface drainage is moderate, but internal drainage may be somewhat slow because of the compact subsoil. The parent material was weathered from slightly clayey limestone. The original cover was a hardwood forest, chiefly oak, hickory, and maple. Most of this phase is in Powell Valley in medium-sized areas, but it occurs in all the limestone valleys. It is associated chiefly with Talbott silty clay loam, eroded rolling phase, and the Rolling and Smooth stony lands (Talbott soil material), but in some places it is associated with soils of the Dewey and Caylor series.

The soil profile is similar to that of Talbott silty clay loam, eroded rolling phase, except that the surface layer is thicker and lighter in texture. A profile description follows:

- 0 to 8 inches, grayish-brown moderately friable heavy silt loam.
- 8 to 30 inches, reddish-yellow or yellowish-red strongly plastic, heavy silty clay with a coarse nut structure.
- 30 inches +, reddish-yellow strongly plastic silty clay spotted with gray, brown, and yellow.

A few small fragments of limestone rock are on the surface in some places. Clayey limestone bedrock is at an average depth of about 5 feet, but the rock floor is jagged and uneven.

The soil is strongly acid in most places. The original supply of humus was not large, and it has been depleted through cropping and erosion. In general, good tilth is maintained without difficulty, but the more seriously eroded areas require special management. Moisture conditions are favorable for crops except during droughts or extended rainy periods.

Variations in this mapping unit, like those in Talbott silty clay loam, eroded rolling phase, are due chiefly to differences in the degree of erosion. A comparatively few areas have lost a fairly large part of the original surface soil, and in these the present plow layer includes some of the upper part of the subsoil. In the eroded areas practices required for maintenance of good tilth and favorable moisture conditions and the control of erosion are essentially the same as those for Talbott silty clay loam, eroded rolling phase.

Present use and management.—Many areas of Talbott silt loam, undulating phase, are used and managed in the same manner as Talbott silty clay loam, eroded rolling phase, inasmuch as the two soils are closely associated. In general these practices are not well adjusted to the physical suitability of the soil. Practically all of it is cleared and cultivated. About 35 percent is used for corn, 25 percent for small grain, 10 percent for tobacco and vegetables, and the remaining 30 percent for hay and pasture. Systematic crop rotations are not generally followed. The kind of crops grown and the length of time a crop remains in a given field is determined by the immediate needs of the farm operator.

Corn and small grains ordinarily receive small applications of 0-10-4 fertilizer or superphosphate. Tobacco is fertilized with barnyard manure if it is available, and in many places this crop receives heavy applications of commercial fertilizer in addition. Hay and pastures receive very little fertilizer. Not much of this soil is limed at regular intervals.

Under present management practices corn yields 28 bushels an acre; wheat, 11 bushels; burley tobacco, 1,000 pounds; and lespedeza, 1 ton. Where lime is used in addition to the common practices, red clover yields 1.4 tons and alfalfa, 2.6 tons.

Management requirements.—Although not so exacting, Talbott silt loam undulating phase, has the same management requirements as Talbott silty clay loam, eroded rolling phase. Apparently the soil can be conserved under a rotation including a row crop once in 3 to 4 years if other management requirements are met. It is fairly well suited to corn, burley tobacco, small grains, and some vegetable crops. Alfalfa and red clover do well when properly treated and add to the organic matter and humus content, improve tilth of the surface soil, and prevent erosion. Medium applications of lime at moderately frequent intervals are necessary to obtain good stands of legumes.

Barnyard manure, in addition to increasing the nitrogen and humus content, furnishes some potash and helps control runoff by improving tilth and increasing the absorptive qualities of this soil. All crops and pasture require potash and liberal applications of phosphorus. These materials are probably most economically furnished through high-analysis commercial fertilizer.

In general, control of runoff and conservation of soil moisture are best achieved by proper choice and rotation of crops and correct use of amendments rather than by mechanical means. Cultivation, however, should be on the contour. Broad-base terraces may be beneficial in some places, but they must be very carefully planned, constructed, and maintained to be effective.

Under good management corn yields about 38 bushels an acre; wheat, 17 bushels; burley tobacco, 1,200 pounds; and lespedeza, 1.3 tons.

Talbott silty clay loam, eroded hilly phase.—This moderately fertile soil is difficult to work and to conserve. It occurs on lower scarp slopes of the valley mountains and is underlain by high-grade limestone. The original forest cover consisted chiefly of oak, hickory, maple, beech, and black walnut. Slopes range from 15 to 30 percent, but most of the soil is on slopes of about 25 percent. Surface drainage is rapid, but internal drainage may be somewhat slow because of the heavy subsoil. This phase occurs in irregularly shaped areas around the head of small watercourses, and on rounded knolls and knobs on the foot slopes of Big Ridge, Cumberland Mountain, and eastern Lone Mountain. The soil is associated with Talbott silty clay loam, eroded steep phase, soils of the Armuchee series, and Rolling stony land (Talbott soil material).

The profile is similar to that of Talbott silt loam, undulating phase, except that it has lost more of the original surface layer because of greater erosion on the steeper slopes. Following is a profile description:

- 0 to 6 inches, grayish-brown to reddish-yellow moderately friable silty clay loam.
- 6 to 24 inches, reddish-yellow to yellowish-red strongly plastic silty clay with a well-developed coarse nut structure.
- 24 inches +, reddish-yellow strongly plastic silty clay splotched with gray, red, and yellow.

Small slabs of limestone rock are on the surface in some places. Limestone bedrock is at an average depth of about 4 feet, but the rock floor is jagged and uneven, and bedrock outcrops are in some places.

The soil is strongly acid where it has not received applications of lime. The content of organic matter is relatively low. Good tilth is moderately difficult to maintain, and soil moisture is conserved with difficulty, especially where tilled crops are grown.

Included in this phase are variations due to differences in the degree of erosion and to the admixture of some sandy colluvial material in the soil. In some places where the soil has been used intensively for growing tilled crops, the original surface layer is entirely missing, and the present surface soil is formed by the upper part of the subsoil. In these places the surface soil is sticky and plastic when wet and hard and intractable when dry. Similar conditions exist in many very small areas where pastures have been overgrazed. Fragments of sandstone rock may be on the surface, and sandy soil material may be mixed in the surface layer in many places along the edges of areas included in this mapping separation. Small areas of Rolling stony land (Talbott soil material) are also included.

Present use and management.—Although fairly well adjusted to the physical suitability of the soil, practices on Talbott silty clay loam, eroded hilly phase, are by no means uniform; and there is

evidence of improper use and poor management in some places. Practically all of this soil has been cleared and used for tilled crops and pasture, but about 20 percent of it has been abandoned and has grown up to second-growth forest. About 40 percent is used for permanent pasture, 25 percent for hay crops, and 15 percent for other crops, including corn, tobacco, vegetables, and small grain.

Where used for tilled crops, systematic crop rotation is not commonly practiced, and the kind of crop grown during a given crop year is determined largely by the immediate needs of the farm operator. Grazing is not carefully controlled on pastures during periods of adverse moisture conditions, and only a few farmers remove weeds by mowing. About half of the pastures receive applications of lime and superphosphate at fairly regular intervals, but the rest ordinarily receives no amendments. Hay crops generally are not fertilized, but most farmers use a small quantity of commercial fertilizer on corn, tobacco, and small grain. Terracing, strip cropping, and control of gullies are not commonly practiced, but tillage is roughly on the contour where the soil is cultivated.

Management requirements.—Talbot silty clay loam, eroded hilly phase, is suited to very limited use, and management requirements are exacting because it is difficult to work and conserve. The soil is not suited to tilled crops and is best used for permanent pasture if that is feasible from the standpoint of good farm management. Bluegrass, white clover, and alfalfa are well suited to this soil, provided liberal quantities of phosphorus are applied and lime is used at moderately frequent intervals. These plants furnish excellent pasture and are effective in increasing the content of organic matter and humus, which in turn increases moisture absorption and circulation and helps control runoff.

Grazing of pastures should be carefully controlled during periods of adverse moisture conditions to prevent injury to the stand and to the tilth of the surface soil. In general, weeds will be largely eliminated where the proper kinds and quantities of amendments are applied. Clipping pastures in spring and fall to destroy weeds may be necessary in places. Check dams are necessary to control gullies.

If farm management requirements make necessary the use of this soil for tilled crops, row crops should not be grown more than once in 7 or 8 years. Liberal applications of lime, phosphorus, and potash will be required, and organic matter and nitrogen should be maintained or increased by growing legumes and sod-forming grasses during a large part of the rotation. Barnyard manure is also effective in this respect and furnishes some potash in addition. Cover crops are very necessary during winter months. Contour tillage should be practiced. Strip cropping may also be effective in controlling runoff and conserving moisture and soil material on the longer slopes.

Talbot silty clay loam, eroded rolling phase.—This soil is low to medium in fertility, rather severely eroded, and has a tough plastic subsoil. It is physically poor to fair cropland. The soil occurs on the slopes of low hills in limestone valleys and is underlain by clayey limestone. It was developed under mixed hardwood forests that included oak, hickory, and maple. Slopes range from 7 to 15 percent. Surface drainage is fairly rapid, but internal drainage is moderately slow because of the heavy subsoil.

The soil is in medium-sized, irregularly shaped areas in Powell Valley, and there are smaller areas in other limestone valleys. It is associated chiefly with other soils of the Talbott series and Rolling stony land (Talbott soil material), but in some places it is mingled with soils of the Dewey, Caylor, and Allen series.

Following is a representative profile:

- 0 to 6 inches, grayish-brown to reddish-yellow moderately friable silty clay loam.
- 6 to 30 inches, reddish-yellow to yellowish-red strongly plastic tenacious silty clay with a coarse nut structure.
- 30 inches +, reddish-yellow strongly plastic silty clay spotted with gray, yellow, and red.

A small amount of chert may be on the surface and in the soil. Small flaggy slabs of limestone are on the surface, and bedrock outcrops in some places. Clayey limestone bedrock is at an average depth of about 5 feet, but the rock floor is uneven and jagged, and there are some surface outcrops.

The soil is strongly acid. The moderately low content of organic matter it originally contained has been greatly depleted through cropping and erosion. Over a large area much of the original surface layer has been lost through accelerated erosion. Good tilth is generally rather difficult to maintain because the heavy subsoil material, sticky and plastic when wet and hard and intractable when dry, becomes mixed with the remaining part of the surface soil.

Tilth, moisture conditions, and accelerated erosion are closely related in this phase. The tight compact subsoil greatly impedes water root, and air movement. Slow moisture movement causes alternate wet and dry conditions in the surface soil, and crops are injured by droughts or extended wet periods. Slow percolation of water through the subsoil layer causes heavy surface runoff and may result in serious soil erosion. As erosion becomes more severe, conditions for absorption and percolation of moisture becomes less favorable, and the susceptibility to further erosion becomes progressively greater.

Variations included in this mapping unit are those chiefly due to differences in degree of accelerated erosion. In many places nearly all the original surface soil is missing and the present plow soil is heavy, sticky, and plastic; whereas in the few areas only slightly eroded, the surface is moderately friable. Other areas are intermediate in this respect. Bedrock outcrops are also more numerous in the more severely eroded areas, and the rock is at shallower depths.

Present use and management.—Talbott silty clay loam, eroded rolling phase, has been used and managed in ways not suited to its physical properties. Practically all the soil is cleared, but about 10 percent is idle each crop season. An estimated 25 percent is used for corn, 30 percent for hay, 25 percent for pasture, and the remaining 10 percent for other crops. Little burley tobacco is grown. Systematic rotation of crops is not commonly practiced; many farmers grow corn for a few years in succession and then let the land lie idle for several years. Others alternate corn and hay according to their farm needs.

Corn usually receives about 100 pounds of 0-10-4 or 0-20-0 fertilizer an acre, and small grains are treated with like quantities of similar fertilizer. Hay and pasture ordinarily receive no fertilizer. Little of the soil used largely for growing tilled crops receives periodic applications of lime, but areas used chiefly for pasture are limed at fairly regular intervals. Tillage is generally on the contour.

Under prevailing management practices corn yields about 20 bushels an acre; wheat, 10 bushels; burley tobacco, 900 pounds; and lespedeza hay, 0.8 ton. Where lime is used in addition to other practices red clover yields 1 ton and alfalfa 1.7 tons.

Management requirements.—Talbot silty clay loam, eroded rolling phase, is exacting in its requirements for good management. Careful practices for controlling runoff and erosion; improving tilth of the surface soil; bettering moisture conditions for plant growth; and increasing supplies of humus, lime, and mineral plant nutrients are required. This soil is best used for hay and pasture crops where that is practical from the standpoint of good farm management; but if careful management is practiced, it can be conserved under a rotation including intertilled crops once in 6 years. A rotation of corn followed by a small grain seeded to a pasture or hay crop is desirable. The soil is not well suited to tobacco.

Alfalfa, red clover, and sod-forming grasses, especially bluegrass, will improve the fertility and workability of this soil and help prevent erosion. It is especially important that cover crops be kept on this soil during fall and winter. Grazing of pastures should be carefully controlled during periods of adverse moisture conditions. Liberal applications of mineral fertilizer containing potash and phosphorus are necessary for good growth of legumes and grasses—the plants essential to maintenance or improvement of the productivity. Lime is required in medium quantities at moderate intervals.

Although runoff and erosion should be controlled largely by proper choice and rotation of crops and the use of adequate amendments, some other practices are necessary in most places. Strip cropping may be beneficial on some of the longer slopes, and contour tillage is necessary everywhere. Terraces may be effective means of controlling erosion in some areas, but they must be well planned and carefully maintained.

Talbot silty clay loam, eroded steep phase.—This moderately fertile soil is very difficult to work and conserve; it occurs on the lower slopes of mountain ridges. It is similar to Talbot silty clay loam, eroded hilly phase, but has stronger slopes. Like other Talbot soils, it has a heavy compact subsoil. The parent material was weathered from clayey limestone, and the soil developed under a hardwood forest of oak, hickory, maple, beech, and black walnut. Slopes range from 30 to 60 percent—most of the soil having slopes of less than 40 percent.

This phase is on the northern foot slopes of the eastern Lone Mountain, on Big Ridge, and on the ridges extending from the Cumberland Mountains. The small or medium-sized irregularly shaped areas are associated with Talbot silty clay loam, eroded hilly phase, soils of the Armuchee series, and Rough stony land (Fullerton soil material).

The profile of this soil is similar to that of Talbot silty clay loam, eroded hilly phase, though more of the surface layer has been removed by accelerated erosion. Small slabs of limestone rock are on the surface and in some places. Bedrock is at a depth of about 4 feet, but surface outcrops and ledges are rather common.

The soil is strongly acid, low in organic matter, and at least moderately deficient in lime, phosphorus, and potash. Runoff and erosion are difficult to control because slopes are steep and the subsoil is compact. The subsoil layer is slowly permeable and unabsorptive of water, and much rainfall is lost in runoff. Where the surface of the soil is unprotected by vegetation, runoff is very rapid. Large quanti-

ties of suspended soil material are carried off, and gullies are cut in many places.

The variations included in this phase are due to differences in degree of erosion and to the presence of some sandy colluvial material in the surface soil. Where erosion is severe, all of the original surface soil is missing and the upper part of the original subsoil is at the surface. At such places the surface soil is sticky and plastic when wet, and hard and intractable when dry. Sandy soil material has washed from higher slopes onto this soil in a few places, and in these a few inches of the surface soil has a fine sandy loam texture. Fragments of sandstone rock are also on the surface in these places. The variations are not extensive and do not materially alter management requirements.

Present use and management.—Practically all of Talbott silty clay loam, eroded steep phase, is cleared and used for pasture. Improvements are needed in management practices. Fertilizer or other soil amendments are not ordinarily used, and other special management practices are not followed. About 30 cow-acre-days of grazing can be expected under present practices. In the few places where tilled crops are grown, yields are very low.

Management requirements.—Because it is difficult to work and conserve, Talbott silty clay loam, eroded steep phase, is suited only to pasture. Management requirements should be designed to provide amendments, fertilizer, organic matter, and moisture in quantities sufficient to obtain good stands of pasture plants. Moderate applications of lime at fairly frequent intervals and liberal additions of phosphorus are required to obtain good stands of red clover, white clover, and bluegrass. When these sod-forming crops become established, they are effective in controlling runoff and in preventing loss of soil material through erosion. The roots bind the soil and check the flow of water. The increased content of organic matter and the improved water-absorbing capacity of the soil further decrease runoff.

Grazing should be controlled so that good stands of pasture plants can be maintained, and weeds should be controlled by clipping or other means. Shading by thin plantings of locust or black walnut may be beneficial to pastures on this soil.

Tyler silt loam.—This soil is on level or slightly depressed positions above present overflow on old stream terraces in shale valleys. It is low in fertility and poorly drained. Parent materials are derived from stream alluvium that washed largely from uplands underlain by shale, but some sandstone material is included. The soil was developed under hardwood forest. Slopes are less than 3 percent, and both internal and surface drainage are very slow.

This type is in Powell Valley and along Bullrun Creek associated with Leadvale, Jefferson, Philo, and Pope soils of the adjoining colluvial soils and bottom lands, and Montevallo, Lehew, and Muskingum soils of the nearby uplands.

Following is a representative profile:

- 0 to 5 inches, gray very friable silt loam.
- 5 to 15 inches, yellowish-gray friable silt loam or silty clay loam spotted with brown, yellow, and red.
- 15 inches +, bluish-gray or light-gray somewhat compact silty clay loam spotted with brown and yellow.

Shale bedrock is at depths of a few to several feet.

The soil is very low in organic matter and strongly to very strongly acid. Moisture conditions are unfavorable for the growth of most crop plants. Water stands on the surface through all the wetter seasons of the year, but the surface layer may dry out late in summer. Some of the areas included have a fine sandy loam surface soil and a fine sandy clay loam subsoil.

Present use and management.—All of Tyler silt loam is cleared and used chiefly for pasture. Redtop, common lespedeza, and various wild grasses are the chief pasture plants. No lime, fertilizer, or other amendments are ordinarily used, and yields are low and of poor quality.

Management requirements.—Both the quality and quantity of grass can be improved by good management, and most of Tyler silt loam can be profitably used for grazing. If lime and phosphate are used in adequate quantities, a mixture of bluegrass and white clover is well suited to the soil; and if a hay crop is needed, alsike clover may do fairly well. Lespedeza and redtop are other forage crops suited to the soil. Surface drainage can be improved in many places by open ditch drains and bedding. Where drainage is improved it is possible to obtain better stands of desirable pasture plants and the soil can be grazed longer.

LAND CLASSIFICATION, SOIL USE AND MANAGEMENT, AND ESTIMATED YIELDS

LAND CLASSIFICATION

In land classification, soils are grouped according to their physical¹⁰ suitability for agricultural use. Three conditions—productivity, workability, and conservability—determine the suitability of soils for agriculture, and by evaluations of these factors, the soils are placed in five land classes as follows: First-, Second-, Third-, Fourth-, and Fifth-class soils. The three factors of evaluation are first defined.

Productivity refers to the capacity of soils to produce crops. The five relative terms used to describe productivity are very high, high, moderate, low, and very low. Soils of very high productivity have a good supply of available plant nutrients, moisture relations that are most nearly ideal, a reaction approaching neutral, and conditions favorable to good root development. Soils defined as of high, moderate, low, and very low productivity are successively less favorable to plant growth.

Workability refers to the ease of tillage, harvesting, and other field operations. Texture, structure, consistence, stoniness, and degree of slope are important among the properties that affect workability. The six relative terms used to describe workability are excellent, very good, good, fair, poor, and very poor. Soils of excellent workability are generally light to medium in texture, stone-free, and nearly level; and on these a minimum effort is required in tillage and harvesting operations. It is successively more difficult to perform normal farming

¹⁰ The term "physical" connotes such external and internal soil properties as texture; structure; consistence; reaction; content of essential plant nutrients, lime, and organic matter; kinds and number of micro-organisms, insects, and earthworms; moisture relations; slope; stoniness; erosion; and many factors that might affect the kind and quantity of plant growth on the soils.

operations on soils of very good, good, and fair workability, but even on these soils, crops that require tillage can be feasibly grown.

Silty clay or clay soils, hilly soils, or soils that contain enough stones to interfere seriously with cultivation have fair workability. Soils on which normal tillage operations can be performed only with great difficulty have poor workability. Such soils in this area generally have slopes in excess of 25 percent or are so stony that tillage with ordinary implements is almost precluded. Soils with very poor workability are so steep or so stony, or both, that tillage is generally limited to the use of hand implements.

Conservability refers to the ease of maintaining or improving the productivity of a soil and is evidenced by the degree to which the soil responds to good management practices. The relative terms used to describe conservability are the same as those for workability. The principal factors in rating conservability are; (1) Ease of keeping the content of available plant nutrients at a high level, (2) ease of controlling runoff and consequent loss of soil material, and (3) ease of maintaining good tilth and good conditions for tillage.

Excellent conservability means that the productivity and workability of the soil can be maintained without intensive management. Soils of very good, good, and fair conservability, respectively, have conditions that require successively more intensive management, but their productivity and workability generally can be conserved under the good management practices feasible for crops requiring tillage. Soils of poor conservability, if used for tilled crops, can be maintained only by intensive management practices not feasible on most farms. Maintenance of productivity, workability, or both, is extremely difficult on soils having very poor conservability.

On the basis of productivity, workability, and conservability the soils are grouped as First-, Second-, Third-, Fourth-, and Fifth-class soils. Information from farmers, soil surveyors, extension workers, experiment station personnel, and others who work with the soil was used in classifying. For example, a farmer knows that some soils on his farm are better suited to agriculture than others. By comparisons of this nature within farms and among farms, soils can be placed approximately in descending order of their physical suitability for agriculture. Information based on experience is lacking for some soils, but ratings for these are arrived at by comparing them with soils of similar productivity for which information is available. The limits selected for the five land classes are approximate. The soils adjacent to the upper and lower limits of a given land class are marginal between the class in which they have been placed and the one adjoining. For example, Lindside silt loam is classified at the upper limit of the Second-class soils, and it is therefore marginal between First- and Second-class soils.

The soils are placed in the five land classes to provide information on their relative suitability for the present agriculture of the area, not for the purpose of recommending use. Before even general recommendations on land use can be made, information on several other factors is necessary; and before recommendations for use on a specific farm can be made, knowledge of a great many factors applying to that farm are required.

A broad perspective of the land classes can be obtained from figure 3, which shows their distribution by generalized areas (I to VI) and the

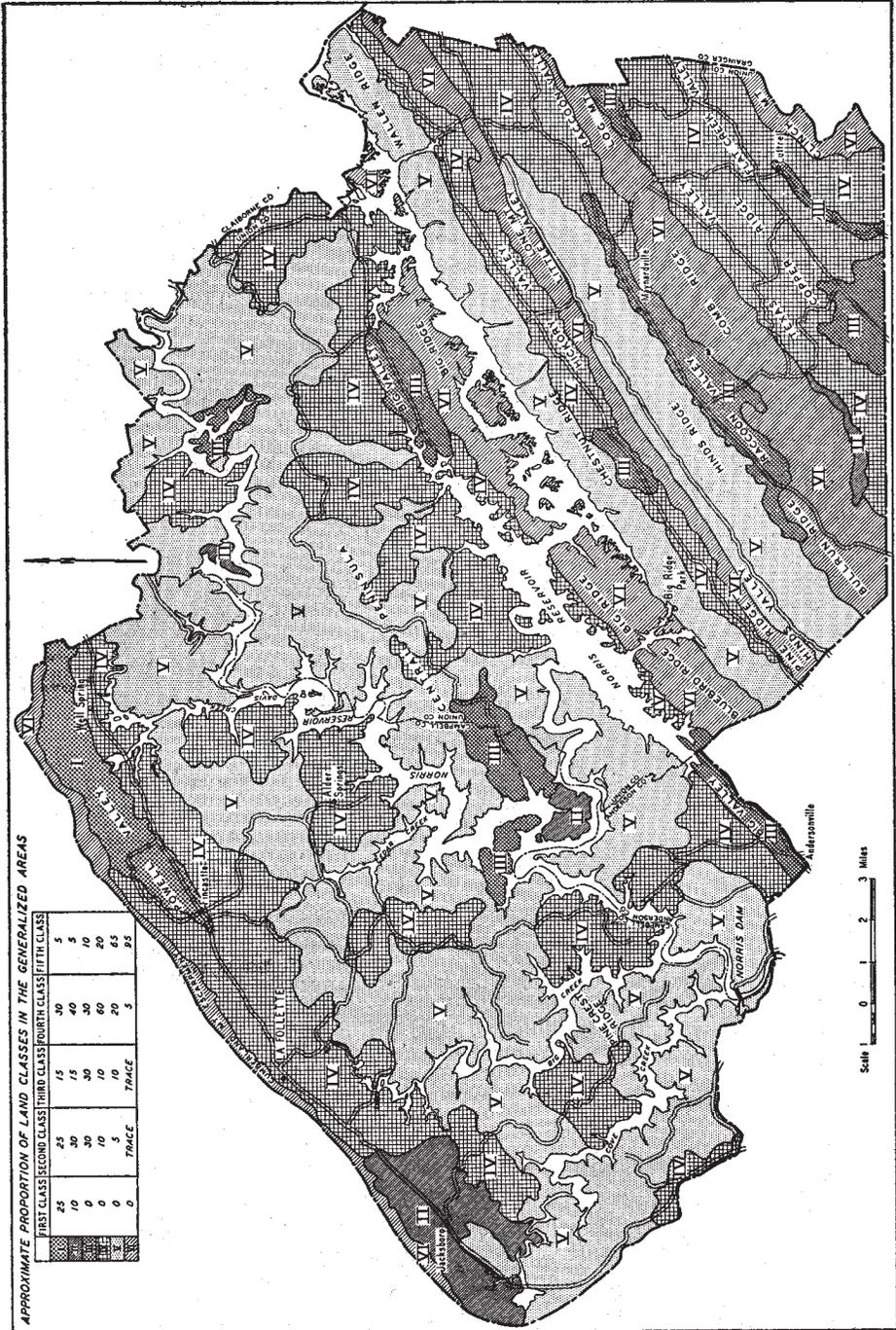


FIGURE 3.—Distribution of land classes by generalized areas (1 to VI); the approximate percentages of First-, Second-, Third-, Fourth-, and Fifth-class soils in the generalized areas are shown in the map legend.

approximate percentages of First-, Second-, Third-, Fourth-, and Fifth-class soils in those areas. This map is designed to show the general use capability of broad areas. It is not a grouping on which recommendations for management can be based, and it cannot be used to determine the physical capability of a particular farm.

FIRST-CLASS SOILS

First-class soils are very good for use in the agriculture of the Norris area. They are good to excellent for crops that require tillage and also for permanent pasture. All are relatively well supplied with plant nutrients, when compared with other soils of the area, but on all of them some crops are responsive to fertilization. The soils of this class, although usually slightly deficient in lime, contain more than most others of the area. All are well drained, but their physical properties are such that they retain moisture well, and an adequate and even supply for plant growth is maintained. Good tilth is easily obtained and maintained, and the range of moisture conditions for tillage is comparatively wide. The soils are fairly well supplied with organic matter in comparison with others of the area and have properties that favor normal circulation of air and moisture and free root penetration of the subsoil.

None of these soils has any prominent adverse soil conditions. They are almost free of stone, their relief is favorable to soil conservation and tillage, and none is severely eroded or highly susceptible to erosion. The natural fertility of these soils is relatively high; they are easily tilled; and the problem of conserving soil fertility and the soil material itself is relatively simple. All are well suited to the common crops of the area.

SECOND-CLASS SOILS

Second-class soils are good for agriculture. They are fair to good for crops that require tillage and fair to excellent for permanent pasture. Soils of this class are at least moderately productive of most of the crops commonly grown in the area. Their physical properties are at least moderately favorable for tillage, maintenance of good tilth, and normal circulation and retention of moisture. None occupies slopes greater than 12 to 15 percent, none is sufficiently stony to interfere seriously with tillage operations, and none is severely eroded. Each soil is moderately deficient in one or more properties that contribute to productivity, workability, or conservability; but none is so seriously deficient in any property that it is poorly suited to use for crops that require tillage.

The deficiencies vary widely among the soils. Some are fertile but sloping and moderately eroded; others are almost level and uneroded but have a relatively low content of plant nutrients or restricted drainage. Management requirements vary widely because of the many different kinds of soils included. The soils of the group are relatively similar in their suitability for agriculture, although the necessary management practices differ greatly.

THIRD-CLASS SOILS

Third-class soils are fair for agriculture. They are poor to fair for crops that require tillage and fair to very good for permanent pasture. Each soil is so deficient in workability, conservability, or productivity, or in some combination of the three, that its suitability

for crops requiring tillage is definitely limited. These soils are better suited to crops requiring tillage than Fourth-class soils but are less well suited than Second-class soils. One or more conditions—low content of plant nutrients, low content of organic matter, low water-holding capacity, undesirable texture, structure, or consistence, strong slope, stoniness, or inadequate natural drainage—limits the suitability of the soil for tilled crops. Because of the diversity of characteristics among the soils of this group, management requirements range widely.

FOURTH-CLASS SOILS

Fourth-class soils are poor for tilled crops and are poor to very good for permanent pasture. They are poor for agriculture, mainly because they are well suited to only a limited number of uses. Some of them, however, may be the most important ones on farms where soils well suited to permanent pasture are in great demand.

All soils of this class are so difficult to work or to conserve, or both, that under present conditions on many farms the management practices necessary for their successful use for crops requiring tillage are not feasible. The soils are generally used for pasture on farms where an adequate acreage of soils well suited to crops is available. On some farms, however, soils well suited to crops requiring tillage may be so limited that it is well to practice the intensity of soil management necessary to achieve successful use of Fourth-class soils for tilled crops. A considerable acreage of Fourth-class soils is used for crops on such farms, but when they are used for that purpose, the intensity of management practiced is generally inadequate for good soil conservation. As on the soils of the Third-class, management requirements, both for crops requiring tillage and for pasture, vary widely among the Fourth-class soils.

FIFTH-CLASS SOILS

Fifth-class soils are very poorly suited to agriculture. They are very poor for tilled crops and poor to very poor for permanent pasture. All soils of this group are so difficult to work, so difficult to conserve, so low in productivity, or have such combinations of these unfavorable properties that it is generally not feasible to apply the intensity of management necessary to achieve their successful use for crops requiring tillage. Each has such a low content of plant nutrients or such poor moisture relations, or both, that common pasture plants produce very little feed. These soils are apparently best suited to forest under present conditions, even though they are less productive of forest than soils of any of the preceding groups. Because better soils may be lacking in a locality, some farm units may need some of these soils for pasture or for crops in spite of their poor suitability.

SOIL USE AND MANAGEMENT¹¹

The suitability of a soil for use, its management, and its productivity are closely interrelated. The physical properties of a soil deter-

¹¹ The term "soil use" refers to broad farm uses, as for crops that require tillage, for permanent pasture, and for forests. The term "soil management" refers to such practices as choice and rotation of crops; application of soil amendments, such as lime, commercial fertilizer, manure, and crop residues; tillage practices; and engineering practices for the control of water on the land.

mine or limit the range of its use suitability, which, in turn, determines its requirements for good management. The way soil is used and managed, together with its physical properties, largely though not entirely determine its productivity. Although use, management, and productivity are determined mainly by physical properties of the soil, many other factors such as economic conditions, climate, and the interests of the farm operators are important. The present use and management, and the practices required for good management, are discussed for individual soils of the area in the section on Soils. The same factors are considered here, but the discussion is on the basis of management groups. The method of deriving these groups is first explained.

In the section on Land Classification, the workability, conservability, and productivity of soils were evaluated, and they were then placed in land classes (First-, Second-, Third-, Fourth-, and Fifth-class soils) according to their physical suitability for agricultural use. The soils placed in a given land class are similar in suitability for agricultural use, but they differ considerably in management requirements because they depart in different degree from the ideal established for the class. One soil may require special practices to improve workability, and another, special practices to increase productivity. For this reason, the soils of the various land classes are divided into groups according to similarity in management requirements.

Before soils can be grouped according to management requirements, a particular use must be assumed. The management requirements of the soils are therefore considered in two broad categories—use for crops that require tillage and use for permanent pasture. The soils of the area are placed in 13 management groups according to similarity in management requirements for crops requiring tillage, but because the requirements for management of permanent pasture are approximately the same for the soils within most of those groups, a separate grouping was not made on the basis of use for permanent pasture. Management requirements for crops requiring tillage and for permanent pasture are therefore discussed together by groups.

In suggesting the management practices for the various soils, it is recognized that some of them may not be feasible for many farmers in the area under present conditions. Many farmers may attain the same objective by using combinations of management practices different from those given in this section but better suited to the particular conditions on their farms. For example, nitrogen can be maintained by the use of legumes, manure, commercial fertilizer, or combinations of the three. The best method for maintaining nitrogen depends on the nature of the farm business as well as on soil conditions.

The general productivity, workability, and conservability of each mapping unit is indicated in relative descriptive terms and the management group and land class are given in table 5.

TABLE 5.—Soils of the Norris area, Tennessee, grouped according to similar uses and management practices, and the general productivity, workability, and conservability of each

GROUP 1				
Soil	General productivity	Workability	Conservability	Land classification ¹
Emory silt loam, undulating phase	Very high	Excellent	Excellent	1
Cumberland silt loam	High	Very good	Very good	1
Dewey silt loam, undulating phase	do	do	do	1
Caylor silt loam, undulating phase	do	do	do	1
GROUP 2				
Lindside silt loam	High	Very good	Very good	2
Ooltewah silt loam	do	Good	do	2
Pope fine sandy loam	Moderate	Excellent	do	2
Philo fine sandy loam	do	Good	do	3
GROUP 3				
Sequatchie fine sandy loam	Moderate	Very good	Very good	2
Roane silt loam	do	do	do	2
Greendale silt loam, undulating phase	do	Good	do	2
Capshaw silt loam	do	do	Good	2
Leadvale silt loam, undulating phase	do	do	do	2
GROUP 4				
Talbot silt loam, undulating phase	Moderate	Good	Good	2
Sequoia silt loam, undulating phase	do	do	do	2
Colbert silt loam, rolling deep phase	do	do	Fair	2
GROUP 5				
Caylor silt loam, rolling phase	Moderate	Very good	Good	2
Greendale silt loam, rolling phase	do	Good	do	2
Fullerton silt loam, undulating phase	do	do	do	2
Fullerton loam, rolling phase	do	do	do	2
Allen loam	do	do	do	2
Bolton silt loam, rolling phase	do	do	do	2
Claiborne silt loam, rolling phase	do	do	do	2
Fullerton silt loam, rolling phase	do	do	do	2
Leadvale silt loam, rolling phase	do	do	Fair	3
GROUP 6				
Dewey silty clay loam, eroded rolling phase	Moderate	Fair	Fair	2
Sequoia silty clay loam, eroded rolling phase	do	do	do	3
Talbot silty clay loam, eroded rolling phase	do	do	Poor	3
GROUP 7				
Clarksville loam, rolling phase	Low	Good	Good	3
Fullerton cherty silt loam, rolling phase	do	Fair	do	3
Fullerton cherty loam, rolling phase	do	do	do	3
Jefferson stony fine sandy loam, rolling phase	do	do	do	3
Clarksville cherty silt loam, rolling phase	do	do	do	3
GROUP 8				
Bolton silt loam, hilly phase	Moderate	Fair	Good	3
Claiborne silt loam, hilly phase	do	do	Fair	3
Dewey silty clay loam, eroded hilly phase	do	Poor	do	3
Fullerton silt loam, hilly phase	Low	Fair	do	3

See footnote at end of table.

TABLE 5.—Soils of the Norris area, Tennessee, grouped according to similar uses and management practices, and the general productivity, workability, and conservability of each—Continued

GROUP 9				
Soil	General productivity	Workability	Conservability	Land classification ¹
Alluvial soils, undifferentiated.....	Low.....	Fair.....	Good.....	4
Tyler silt loam.....	do.....	do.....	do.....	4
GROUP 10				
Smooth stony land (Talbot soil material).....	Moderate.....	Poor.....	Fair.....	4
Rolling stony land (Talbot soil material).....	do.....	do.....	do.....	4
Colbert silty clay loam, eroded rolling phase.....	do.....	do.....	Very poor.....	4
GROUP 11				
Talbot silty clay loam, eroded hilly phase.....	Moderate.....	Poor.....	Fair.....	4
Armuchee silt loam, hilly phase.....	do.....	do.....	do.....	4
Armuchee silt loam, steep phase.....	do.....	Very poor.....	Poor.....	4
Dewey silty clay loam, eroded steep phase.....	do.....	do.....	do.....	4
GROUP 12				
Bolton silt loam, steep phase.....	Moderate.....	Very poor.....	Poor.....	4
Claiborne silt loam, steep phase.....	do.....	do.....	do.....	4
Fullerton silt loam, steep phase.....	Low.....	do.....	do.....	4
Fullerton cherty silt loam, hilly phase.....	do.....	Poor.....	Fair.....	4
Clarksville cherty silt loam, hilly phase.....	do.....	do.....	do.....	4
Lehew fine sandy loam, hilly phase.....	do.....	do.....	do.....	4
GROUP 13				
Fullerton cherty silt loam, steep phase.....	Low.....	Very poor.....	Very poor.....	5
Hector stony fine sandy loam, steep phase.....	do.....	do.....	do.....	5
Talbot silty clay loam, eroded steep phase.....	do.....	do.....	do.....	5
Lehew fine sandy loam, steep phase.....	do.....	do.....	do.....	5
Clarksville cherty silt loam, steep phase.....	Very low.....	do.....	do.....	5
Muskingum stony fine sandy loam, hilly deep phase.....	do.....	do.....	Poor.....	5
Muskingum stony fine sandy loam, steep phase.....	do.....	do.....	do.....	5
Montevallo shaly silt loam, rolling phase.....	do.....	do.....	Very poor.....	5
Montevallo shaly silt loam, steep phase.....	do.....	Poor.....	do.....	5
Rough stony land (Fullerton soil material).....	do.....	Very poor.....	do.....	5
Rough gullied land (Talbot soil material).....	do.....	do.....	Poor.....	5
Rough gullied land (Montevallo soil material).....	do.....	do.....	Very poor.....	5
Limestone rockland, (rolling).....	do.....	do.....	do.....	5
Limestone rockland, (rough).....	do.....	do.....	do.....	5

¹ 1=First-class soils (good to excellent cropland and good to excellent pasture land); 2=Second-class soils (fair to good cropland and fair to excellent pasture land); 3=Third-class soils (poor to fair cropland and fair to very good pasture land); 4=Fourth-class soils (poor cropland and poor to good pasture land); 5=Fifth-class soils (very poor cropland and poor to very poor pasture land; best suited to forest under present conditions).

MANAGEMENT GROUP 1

Good to excellent crop and pasture soils are included in management group 1. All the soils are high to very high in productivity and are easily to very easily worked and conserved. They have gentle slopes and are not seriously eroded or susceptible to severe erosion. All of them are relatively high in lime, organic matter, and plant nutrients, as compared with soils of most other groups, and all have moisture conditions favorable for plant growth. In spite of their favorable properties, these soils are of relatively small importance to the agriculture of the area as a whole because their total acreage is small.

Management requirements.—The soils of group 1 are suited to intensive use and a wide variety of crops, including corn, burley tobacco, soybeans, small grains, alfalfa, red clover, crimson clover, sweetclover, and various vegetable crops. When other management requirements are met, these soils can be conserved and their productivity maintained or increased under rotations that include a row crop in alternate years. Winter cover crops and green-manure crops are useful in conserving soil moisture and improving tilth, and are a source of nitrogen and humus.

Although these are more fertile than any other soils of the area, they are generally slightly to moderately deficient in lime, phosphorus, nitrogen, and possibly potash. Properly conserved barnyard manure is an excellent source of nitrogen and potash and also serves to increase the humus supply of the soils, but it should be supplemented with some form of phosphate fertilizer to obtain the correct balance of plant nutrients. Where an adequate supply of manure is not available, corn, tobacco, small grains, vegetables, and similar crops will respond to moderate to large applications of a complete commercial fertilizer. Legumes require phosphorus and potash but need no nitrogen when they are properly inoculated. Lime is necessary to secure good stands of legumes and will increase the yields of most crops if other management requirements are met. Lime should be applied in moderate to large quantities at relatively long intervals.

Good tilth is easily maintained, and tillage operations can be carried on over a fairly wide range of moisture conditions without seriously impairing the physical properties of the soils. Controlling erosion and conserving soil moisture are not serious problems on these soils when crops are properly chosen and adequate amendments are used. Engineering devices for water control are not ordinarily needed, but contour tillage is a good practice wherever feasible. Careful management of adjoining uplands, however, is necessary in order to control runoff. Otherwise, two soils of this group—the undulating phases of Caylor and Emory silt loams—may be flooded and covered by heavy subsoil material from the eroding uplands.

Soils of this group are rarely used for pasture, because they are so well suited to more intensive use. When used for this purpose, the supplying of amendments, chiefly lime and phosphorus, to suitable pasture plants is the chief requirement. Other requirements include proper control of grazing and the scattering of droppings. On properly grazed pastures that receive adequate amendments, the problem of weed control is not serious, but occasional mowing may be necessary to remove excess herbage and undesirable plants.

MANAGEMENT GROUP 2

The soils of management group 2 are good for both crops and pasture. As a group they are moderate to high in productivity, easily worked, and very easily conserved. All are on first bottoms except Ooltewah silt loam, which is in the bottom of depressions, and all are subject to annual overflow or flooding. Pope fine sandy loam is well-drained, but the other soils are imperfectly drained. The Ooltewah and Lindsides soils are medium to slightly acid and generally are fairly well supplied with lime as compared with the soils of the adjacent uplands, whereas the Pope and Philo soils are strongly acid and are generally low in lime.

Most of the soils in the group, particularly the Philo, have some deficiencies in nitrogen, phosphorus, potassium, and lime. Imperfect drainage limits somewhat the variety of crops that can be grown on the soils, but adequate supplies of moisture for plant growth are generally available, and crops are not injured by droughts so easily as on the adjacent uplands. Because they have at least moderately favorable physical properties and a fairly large acreage and are located in areas where the acreage of soils well suited to crops is very small, the soils of this group are very important in the agriculture of the area.

Management requirements.—Favorable workability and conservability make the soils of group 2 suitable to intensive use, but the variety of crops that can be grown is limited by imperfect drainage and susceptibility to overflow. Wheat, corn, soybeans, crimson clover, alsike clover, redtop, bluegrass, white clover, and many vegetables can be expected to do fairly well. The soils are generally poorly suited to alfalfa, sweetclover, red clover, oats, barley, and burley tobacco. Row crops, including corn and truck crops, can be grown every year or in alternate years, but some green-manure or winter cover crops are needed to maintain or increase humus and nitrogen. Where practical from the standpoint of good farm management, a 3- to 4-year rotation of corn, wheat, and hay is suited to the soils. Tobacco also can be used in this rotation but not so successfully as on soils with better drainage.

Even though these soils receive annual increments of soil material, they are generally deficient in lime, phosphorus, potash, and nitrogen, inasmuch as the upland soils from which the materials are washed are relatively low in fertility. Apparently all crops except legumes require moderate to large applications of a complete fertilizer. Legumes need large quantities of phosphorus and potash but no nitrogen. Lime is necessary to obtain satisfactory stands. Since lime increases the yields of legumes and improves the quality of other crops, it should be applied in small quantities at relatively frequent intervals.

All of these soils are easily maintained in good tilth, although tillage operations may be delayed in spring and during wet periods because of unfavorable moisture conditions caused by imperfect drainage. The soils are not ordinarily susceptible to erosion, but the use of suitable vegetation or engineering structures may be necessary to stabilize stream banks in some places. The range of use suitability and general productivity can be improved by artificial drainage, but the advisability of drainage and the kinds of drains to use on any particular area will depend upon many factors, including cost, feasibility of drainage from an engineering standpoint, and kinds and acreages of other soils on the farm.

The soils of this group are well suited to pasture. Fairly good pastures can be obtained with few special practices other than plowing and seeding. The use of lime and phosphorus, however, will improve the quality and increase the yields of pasture. Excellent bluegrass and clover pastures are obtained by the use of these materials. The scattering of droppings will maintain an adequate supply of potassium for pastures on these soils, although some potassium from commercial fertilizer may be required to establish the stand. During wetter seasons control of grazing to prevent trampling of the pastures and injury to the physical properties of the soils is important. Mowing to eradicate weeds and remove excess herbage is necessary for pastures.

MANAGEMENT GROUP 3

The soils of management group 3 are good for crops and fair to good for pastures. As a group they are moderate in productivity and have good to very good workability and good to very good conservability. They are on colluvial or alluvial lands and low stream terraces with slopes of 2 to 10 percent. The greatest acreage has slopes near the middle of the range.

As a group, these soils have good moisture relations, and they are uneroded or slightly eroded. They are relatively low in lime, organic matter, and mineral plant nutrients but have slightly more of these materials than the soils of group 5. Moisture is readily absorbed and circulated and fairly well retained by these soils. The supplies in the soils are apparently maintained or replenished to some extent by seepage from surrounding upland slopes so that adequate moisture for plant growth is available in all periods except those of severe and prolonged drought. Because of the moderately large acreage, moderately favorable properties, and ready response to good management, the soils of this group are very important to the agriculture of the Norris area.

Management requirements.—Because of their favorable physical properties, moderate fertility, and slight susceptibility to erosion, the soils of group 3 are suited to intensive use. They can be used for a wide variety of crops, including corn, small grains, and all kinds of legumes and grasses suited to the region. Burley tobacco and vegetables do especially well. The soils can be conserved when used for row crops every year or in alternate years. When the soils are so used, crimson clover, winter oats, rye, or similar crops should be sown to protect the soil in winter, and in spring they should be turned under to increase the supply of nitrogen and humus. Where it is practical from the standpoint of farm management to use longer rotations, a row crop followed by a small grain seeded to hay is well suited to the soils.

Although these soils are younger and less leached than the associated soils of the uplands, they are generally at least moderately deficient in phosphorous and nitrogen and probably in potash. Corn, small grains, and grasses need fertilizer containing moderate quantities of nitrogen and potash and large quantities of phosphate. Tobacco and vegetables have similar requirements, except that the proportion of potash should be somewhat higher. Legumes and legume-grass mixtures that have been properly inoculated need no nitrogen, but they do require large quantities of phosphorous and potash. Barnyard manure is an excellent source of humus, nitrogen, and potash if applied in sufficient quantities, but it should be supplemented with some form of phosphorous to obtain the correct balance of plant nutrients.

These soils are generally acid, and lime is needed in most places to obtain good stands of legumes. Small or moderate quantities of lime at rather frequent intervals should be used, but it is advisable to determine the acidity of these soils by chemical test and use the results as a guide.

Where crops are properly selected and rotated and treated with adequate amendments, these soils ordinarily have no special problems of water control, although tillage should be on the contour wherever practical. In most places the management of adjoining upland soils

directly affects the soils of this group. If the upland soils are not managed well, these may be covered with heavy subsoil material washed from adjoining eroding hillsides; and in consequence, their workability and fertility is impaired and their productivity is reduced. The soils should be protected from such overwash by all feasible methods, principally by improving the use and management of the associated upland soils.

As with the other groups already discussed, the soils of this group are suitable to at least moderately intensive use and therefore their use for pasture is largely precluded, especially since they are in parts of the area where the proportion of crop-suited soils is relatively small. Pasture management requirements are very similar to those described for the soils of group 2. They are chiefly the supplying of lime, phosphorous, and potassium to properly selected pasture mixtures; the proper control of grazing; the scattering of droppings of grazing animals; and the removal of excess herbage and weeds by mowing.

MANAGEMENT GROUP 4

On the whole the soils of management group 4 are good for crops and pasture. They are moderate in productivity and as a group have good workability and conservability. All are in undulating limestone valleys on slopes of 2 to 8 percent. The soils are characterized by a tough subsoil and shallowness over bedrock and are slightly eroded and at least moderately susceptible to erosion. All are at least moderately deficient in organic matter and essential plant nutrients and are acid to strongly acid. Moisture supplies are generally inadequate for good plant growth, and crops are injured by lack of moisture during droughts.

Management requirements.—The soils of group 4 are suited to moderately intensive use. They can be used for corn, small grains, burley tobacco, legumes, and grasses. When other management requirements are met, they can be conserved under rotations including a row crop once in 3 to 5 years. Leguminous and sod-forming grasses are useful in each rotation as a means of controlling runoff and increasing or maintaining the nitrogen and humus supplies.

These soils are at least moderately deficient in lime, phosphorus, potash, and nitrogen. Corn, small grains, burley tobacco, grass hays, and like crops require moderate to large quantities of complete fertilizer. Legumes ordinarily need only phosphorus and potash, but lime is necessary to obtain good stands. The yields and quality of other crops are improved by lime, which is needed in medium quantities at moderately frequent intervals. Lime is best applied just before the legume in the rotation is seeded. Barnyard manure is an excellent source of nitrogen and potash if supplied in sufficient quantities and supplemented with some form of phosphorous to obtain the proper balance of plant nutrients.

Moderate care is required in the selection of proper moisture conditions for working these soils, but otherwise good tilth is fairly easily maintained. The proper selection and rotation of crops and the use of soil amendments are partly effective in controlling runoff, but other practices are required. Contour tillage and, on longer slopes, strip cropping are effective aids in conserving soil moisture and materials. In some places properly planned, constructed, and maintained terraces also are effective.

Good pastures are easily established and maintained on these soils, but in many places greater returns can be obtained by more intensive use. Grass and legume mixtures, including bluegrass, orchard grass, white clover, lespedeza, hop clover, and many other plants are well suited to these soils. Moderate to heavy applications of lime, phosphorus, and possibly potassium are needed on most pastures, but mixtures that include a fair proportion of legumes ordinarily require no nitrogen. On established pastures the scattering of droppings will probably insure an adequate supply of potassium. Careful control of grazing during periods of adverse moisture conditions is important both as a measure to protect pasture stands and as a means of preventing injury to the physical properties of the soils. On properly grazed pastures that have received adequate amendments, weed control is not a serious problem; but during seasons of rapid growth, clipping to remove excess herbage and eradicate weeds may be necessary.

MANAGEMENT GROUP 5

The soils of management group 5 are good for both crops and pasture. As a group they have moderate productivity, good workability, and good conservability. They are generally somewhat lower in natural fertility than the soils of group 6, but are lighter in texture and more friable, especially in the subsoil, and are less eroded and less susceptible to erosion. Slopes range from 5 to 12 percent. The soils are slightly to moderately eroded and absorb and retain moisture well. The moisture circulates freely and supplies an adequate amount for plants under normal conditions. Crops may be injured to some extent, however, by lack of moisture during periods of even moderate drought. Because these soils have a large acreage and are well suited to crops and responsive to good management, they are, as a group, of considerable importance to the agriculture of the area.

Management requirements.—Although the soils of group 5 are relatively low in natural fertility, they are suited to moderately intensive use because of their favorable physical properties and their responsiveness to good management. All or nearly all of the crops commonly grown in the county do well on these soils, especially burley tobacco, vegetables, and fruits. The soils can be conserved under a rotation including a row crop once in 3 years. A row crop seeded to small grain followed by a legume is a useful rotation. Legumes and green-manure crops should have an important place in the cropping system, inasmuch as they are effective in maintaining or increasing the supplies of humus and nitrogen, in conserving moisture, and in preventing erosion.

These soils are low in nitrogen, phosphorus, potash, and lime. Wherever barnyard manure is available, it should be applied in liberal quantities as a source of nitrogen, potash, and humus and as a means of improving tilth and increasing the moisture-holding capacity. Some form of phosphorus should be used with the manure to obtain a correct balance of plant nutrients. Where manure is not available or is available in only limited quantities, a complete commercial fertilizer is needed for corn, small grains, tobacco, vegetables, and grasses. Legumes and legume-grass mixtures require phosphorus and potash but no nitrogen if they are properly inoculated. Lime is necessary to insure success with legumes, because it neutralizes soil acidity and furnishes calcium to the plants.

Good tilth is easily maintained, and tillage can be carried on over a wide range of moisture conditions without injury to the soils. Where crops are properly selected and rotated and receive adequate supplies of fertilizer and other amendments, runoff and erosion are greatly reduced, but other practices for water control are needed. All tillage operations should be done on the contour if feasible. On the longer slopes where the soils are intensively used, strip cropping is effective in conserving moisture and preventing erosion. Terraces may be useful in some places; but they must be carefully planned, constructed, and maintained to be effective.

The soils of this group are well suited to pasture, but because of their suitability for more intensive uses are seldom used as pasture land. Grasses and legumes, including lespedeza, various clovers, bluegrass, orchard grass, timothy, and redtop, are among the pasture plants suited to the soils in the group. Phosphorus and lime are needed in moderate quantities at relatively frequent intervals. Initial seedings of pasture will probably need potassium as well; but subsequently, scattering of droppings should maintain an adequate supply of this nutrient. Control of grazing is important, especially during the drier summer and early in fall when overgrazing may result in injury to the pasture stand. Occasional mowing of pastures may be needed in spring and in fall to remove excess forage and to eradicate weeds.

MANAGEMENT GROUP 6

The soils of management group 6 are good cropland and good pasture land, and have moderate productivity, fair workability, and fair conservability. They are on rolling uplands with slopes of 7 to 15 percent, and differ from the soils of group 4 chiefly in having stronger slopes and in being more eroded and more susceptible to erosion. Because all these soils are moderately to severely eroded, the subsoil over most of them is turned by plowing and other tillage operations.

Most of the soils are at least moderately deficient in lime, organic matter, and essential plant nutrients. The range of moisture conditions for tillage is rather narrow. Moisture absorption is less favorable than on the soils of the groups previously discussed; losses through runoff are rather large, and crops are injured by drought. Because of their moderate natural fertility and ready response to good management, the soils of this group are important to the agriculture of the area.

Management requirements.—Because of the difficulty of conservation, the soils of group 6 should not be intensely used. They are suited chiefly to close-growing small-grain and hay crops, but under proper management, row crops can be grown once in 5 to 7 years. Wheat, oats, barley, alfalfa, red clover, alsike clover, timothy, and corn are among the crops that do well. These soils are less well suited to burley tobacco than those of groups 1 or 2, and because of their heavy-textured plow layers and moderate tendency to droughtiness, they are unsatisfactory for most vegetable crops. A rotation of corn or tobacco, wheat or other small grain, and hay can be used on these soils. Clover and alfalfa do well where limed, and they fit well into the suggested rotation.

Fertilizer and lime are of great importance because these soils need amendments for continued production of medium to high crop yields. Lime and phosphate are especially needed for legumes and grasses.

Nitrogen is a general requirement, except where it is supplied by legumes. Some potash is generally needed for the legume crop.

Good tilth is moderately difficult to maintain on these soils. If plowed when too wet, they become puddled or cloddy; if they are dry, tillage operations of any kind are difficult. If the soils are plowed in the fall, freezing and thawing will probably serve to improve tilth; but because this advantage is probably more than offset by the increased runoff and erosion, fall plowing is not generally a good practice.

Where these soils are in close-growing grass and small-grain crops much of the time, runoff and erosion are greatly reduced, but further special measures for their control are required. Contour tillage should be practiced wherever feasible. On some of the longer slopes, a system of strip cropping may be useful. Broad-base terraces, carefully planned and constructed and properly maintained, are effective in preventing erosion and conserving soil moisture. All large gullies should be stabilized. Vegetation on the gully banks is effective. Certain trees, chiefly pine and black locust, are useful; and Bermuda grass, kudzu, and sericea lespedeza are among the sod-forming plants that can be used.

All the soils of this group are well suited to pasture. Bluegrass, orchard grass, redtop, white clover, and other pasture legumes do well. Lime, phosphorus, and potassium are needed to establish good pastures. Additional supplies of lime and phosphorus are needed periodically to maintain them, but probably enough potassium can be supplied by scattering droppings. Careful control of grazing is necessary to avoid injury to pasture stands, especially during dry seasons. Clipping is necessary, particularly in the wetter seasons, to remove excess forage and eradicate weeds.

MANAGEMENT GROUP 7

The soils of management group 7 are fair crop and pasture lands. As a group they are low in productivity, fair in workability, and good in conservability. They differ from the soils of group 5 chiefly in being more stony or cherty and lower in natural fertility. All the soils have enough chert or stone on the surface and in the soil layers to interfere materially with tillage. All of them are low in lime, phosphorus, potassium, nitrogen, and organic matter, and are strongly acid. They have slopes of 5 to 15 percent.

The soils absorb water readily but do not retain it well, and crops are injured by droughts of even moderate duration. Surface runoff and erosion are somewhat less than on the noncherty types or phases of the same soil series. In many places these soils have lost much of the fine material in their original surface layer through accelerated erosion and their present surface layer is largely a mixture of chert and subsoil material. In those places the soils are very cherty. In spite of only fair suitability for crops and pasture, the soils of group 7 are very important to the agriculture of the area because of their large acreage and wide distribution.

Management requirements.—The soils of group 7 are suited to less intensive use than those of group 5 because of their less favorable properties and lower response to good management. Corn, small grains, burley tobacco, legume hays, grasses, and some vegetables are suitable crops. Tree fruits, principally peaches, are grown successfully in other parts of Tennessee on soils similar to some of these, and it is assumed that they will do well in the Norris area.

A 4- or 5-year rotation in which a row crop is followed by a small-grain crop seeded to a legume or grass for hay or pasture is well suited to the soils. Sod-forming grasses and legumes should have an important place in the rotations because they are useful in conserving moisture, preventing erosion, and increasing the supplies of humus and nitrogen.

These soils are similar to those of group 5 in their requirements for amendments. Small grain, corn, tobacco, vegetables, and grasses require a complete fertilizer; but legumes need only phosphorus and potash if properly inoculated. Where barnyard manure is available and is used in sufficient quantities in conjunction with some form of phosphate fertilizer, other fertilizers are needed in smaller quantities or not at all. In addition to furnishing nitrogen and potash, manure increases the supply of humus and helps to improve tilth and moisture conditions. Soil acidity must be neutralized by the use of lime before success with legumes can be assured.

Tillage operations can be carried on over a fairly wide range of moisture conditions without impairing tilth. Tilth conditions are generally only fair, however, because of the large quantity of stone or chert on the surface and in the soils. Some improvement can be obtained by removing the larger rock fragments, but it is generally impractical to remove all of them. Where suitable crops are properly rotated and treated with adequate amendments, the control of runoff is already largely accomplished, but a few additional special practices are needed. On the steeper longer slopes strip cropping is an effective means of preventing erosion and conserving soil moisture. Contour tillage should be practiced where feasible. Terraces on these soils are not generally practical, but in some places they may be effective if carefully planned and constructed and properly maintained.

Under a good system of management fairly good pastures can be obtained on these soils, but native pastures consist largely of broom-sedge and other native plants. Good stands of grass-legume mixtures including orchard grass, redbud, lespedeza, and various clovers can be obtained by the use of lime and complete fertilizers. After pastures are established, additional nitrogen is probably not needed if the mixture contains a fair proportion of legumes, but periodic application of other amendments will be required to maintain good stands. Scattering of droppings will help to sustain the potassium supply, but additional quantities from commercial sources may be needed at intervals. The soils are somewhat droughty, and careful control of grazing is therefore necessary during dry seasons to avoid injury to pasture stands.

Where adequate amendments are used and grazing is properly regulated, weeds are few; but occasional clippings for weed eradication may be necessary. Sharp fragments of chert on the chertier parts of many of these soils cause hoof injuries and inhibit grazing by cattle. The chert may make use of the soils for pasture purposes impractical, even though they may produce good yields of forage.

MANAGEMENT GROUP 8

The soils of management group 8 are fair crop and pasture lands. They have low to moderate productivity, fair workability, and fair conservability. They differ from the soils of group 5 chiefly in

having stronger slopes and in being on the whole somewhat more eroded. Slopes range from 12 to 30 percent, the larger proportion of the total acreage having slopes in the middle and upper parts of the range. All except the wooded areas are at least moderately eroded, and all are at least moderately susceptible to further erosion. All have some deficiencies in lime, phosphorus, potassium, nitrogen, and humus, and all except the Dewey soils are light textured and fairly easy to maintain in good tilth.

Water is readily absorbed and retained on all except the more severely eroded areas, but crops are injured by droughts of moderate duration because there is a large loss of water in runoff. In parts of the area where soils suitable for crops are scarce, these soils are of large agricultural importance, but over the area as a whole they are of only moderate importance because of the limited acreage and range of use suitability.

Management requirements.—Because of their stronger slopes, the soils of group 8 are more exacting in their management requirements and more limited in their range of use suitability than those of any of the preceding groups. Wherever practical from the standpoint of good farm management, soils of this group are best used for small grain and sod-forming forage crops, but if necessary, row crops can be grown once in 7 to 10 years if other management requirements are met.

Wheat, oats, barley, alfalfa, red clover, lespedeza, timothy, orchard grass, bluegrass, white clover, and corn are among the crops suited to the soils. Fruit trees, if properly cared for, may do fairly well. Tilth and moisture conditions are not generally favorable for burley tobacco and vegetable crops. Where the soils are kept in sod crops most of the time, erosion is prevented, soil moisture is conserved, and the supplies of nitrogen and humus are increased.

These soils, like those of groups 5 and 7, are low in nitrogen, phosphorus, potash, and lime and require similar fertilization. Small grains require complete fertilizer, as do grass crops. Legumes or legume-grass mixtures require phosphorus and potash but no nitrogen if they are properly inoculated. As on other soils, barnyard manure in adequate quantities is an excellent source of nitrogen, potash, and humus but it must be supplemented with some kind of phosphorus to obtain the proper balance of plant nutrients. Apparently there are no serious deficiencies in minor elements, but unknown shortages may exist because only limited data are available. Lime is necessary to secure good stands of legumes, and it also improves the yields and quality of other crops. It is best applied in small or moderate quantities at rather short intervals. Fertilizer should be supplied in small or medium applications to meet the need of a particular crop rather than in large quantities at long intervals.

Tillage of the soils is moderately difficult because of their strong slopes and eroded condition. Moisture conditions for plowing must be carefully chosen to avoid further impairment of tilth. The soils should never be left bare of vegetation during winter or at any other time of the year for periods longer than are necessary to accomplish needed tillage operations.

Runoff control and moisture conservation can be attained largely through correct choice, rotation, and fertilization of crops, but other

special practices are needed. Seeding of hay and small grains and other tillage operations should be on the contour. Where it is necessary to raise row crops, some system of strip cropping is needed and should be used wherever practicable. In general, terraces cannot be feasibly built on the strong slopes of these soils. Gullies can be controlled by check dams and by the use of suitable vegetation, as pine trees, grasses, kudzu, and sericea lespedeza.

This group of soils is suited to pasture, but less well suited than most groups already described. Management requirements are very similar to those described for group 5. They are concerned chiefly with supplying needed amendments to suitable pasture mixtures, controlling grazing, and eradicating weeds.

MANAGEMENT GROUP 9

The soils of management group 9 are poorly suited to crops, but they are fair to good for pasture. They are low in productivity, at least moderately difficult to work, and fairly easy to conserve. Tyler silt loam is poorly drained, and Alluvial soils, undifferentiated, has imperfect drainage, stoniness, or low natural fertility to such an extent and in such combinations that it is unsuited to use as cropland. Alluvial soils, undifferentiated, is on first bottoms; and Tyler silt loam is on low terraces.

The soils of this group are at least moderately deficient in lime and essential plant nutrients. Both surface and internal drainage are very slow, and in most places they cannot feasibly be improved enough to allow growing tilled crops. Fair yields of grasses and legumes for pasture, however, can be obtained in most places. These soils are not of great importance to agriculture, because of their small acreage and limited range of use suitability.

Management requirements.—Natural pastures on most of the soils of group 9 consist chiefly of broomsedge, wild marsh grasses, and sedges, and in the wettest sites, cattails, sweetflag, and similar plants. These pastures furnish grazing throughout the spring, summer, and fall; but the quality is poor to fair and the carrying capacity is low to medium. Pasture improvement on these soils can be accomplished largely through the use of open ditch drains that are effective in removing much of the surplus surface water. After drainage has been improved, seedings of bluegrass and white clover can be expected to do fairly well if liberal quantities of lime and phosphorus are used. Redtop and lespedeza can be grown with small quantities of amendments, but the pastures obtained are of lower quality. Weeds should be controlled by mowing once or twice during each grazing season. Even under good management, the amount and quality of pasture obtained on these soils will vary considerably according to natural fertility and drainage conditions. In most places the use of the soils of this group for cropland is not feasible under present conditions.

MANAGEMENT GROUP 10

Soils and land types poorly suited to crops but good for pasture are included in management group 10. They are moderate in productivity but have poor workability and fair conservability. They are on undulating to rolling uplands in limestone valleys and are fairly well supplied with lime and mineral plant nutrients. Because of the heavy

texture of the soil material and the large amount of bedrock outcrop, these soils and land types absorb moisture only fairly well. Plants are injured by droughts of short duration, and tillage is made very difficult. The soils of this group are of considerable agricultural importance because they cover a moderately large acreage and are suitable for pasture.

Management requirements.—In some places the soils and lands types of group 10 are most economically used in their natural conditions, whereas in others more intensive management may be profitable. Seeding to bluegrass and white clover will aid in improving pastures. Lime and phosphorus in moderate amounts will greatly increase the proportion of bluegrass and white clover in the pasture mixture, and a higher yield of better quality pasture is thereby obtained. In places applications of potassium may be needed to establish good pastures, but thereafter additional quantities from fertilizer are probably not needed if droppings are scattered. The use of these amendments coupled with carefully controlled grazing will eliminate most weeds, but mowing may be necessary to eradicate some of them. In some places outcrops may be high enough to prohibit the use of a mowing machine.

Even under good management, the carrying capacity of pastures on these lands is greatly reduced during the warmer, drier summer months, and provision should be made for grazing part of the livestock on temporary pastures during these months. Thin shading by widely spaced black locusts and walnuts is apparently beneficial. It is not feasible to use the soils of this group for crops under existing conditions.

MANAGEMENT GROUP 11

Although poorly suited to crops, the soils of management group 11 are good for pasture. They have moderate productivity, poor to very poor workability, and poor to fair conservability. All of them are on hilly and steep slopes, chiefly on the lower scarp slopes of valley mountains bordering limestone valleys, but to some extent on the slopes of hills in the valleys. All have fair supplies of lime, phosphorus, potassium, organic matter, and nitrogen; but most of them have some deficiency in these properties. The cleared areas are at least moderately eroded, and all are susceptible to further erosion. Favorable moisture conditions for plant growth are difficult to maintain under tilled crops, but under close-growing grasses and legumes, moisture is retained and circulated fairly well. Good tilth is also maintained with difficulty under tilled crops. Because of their large acreage and suitability for pasture, these soils are moderately important to the agriculture of the area.

Management requirements.—Both the quality and yields of pastures on the soils of group 11 can be greatly increased by good management. Plowing and seeding to a suitable grass-legume mixture is the first step toward establishing good pastures on many of these soils. Lime and phosphorus are necessary to obtain and maintain good stands of bluegrass and white clover, the plants best suited to permanent pasture. Scattering of droppings will likely serve to maintain potassium at a favorable level on most of these soils, but additional supplies from commercial fertilizer is needed to establish new seedings and on old heavily grazed pastures. Mowing a few times

during the grazing season will serve to eradicate weeds. Grazing should be controlled, because intensive use during dry seasons will injure the stands. Where adequate amendments are used on suitable plants and grazing is carefully controlled, erosion will be reduced and moisture conditions improved so that the yield and quality of pastures will be gradually improved up to a certain level. Generally, no special practices for runoff control are feasible or needed other than the stabilization of gullies. Thin shading by widely spaced walnut and black locust trees will be beneficial to the pastures.

MANAGEMENT GROUP 12

The soils of management group 12 are poorly suited to crops but are fair for pasture. As a group they have low productivity, poor to very poor workability, and poor to fair conservability. All except one are on hilly and steep slopes in the cherty ridge area. Lelew fine sandy loam, hilly phase, is on comby ridges. These soils differ from those of group 11 chiefly in being lower in natural fertility. The cleared areas are moderately eroded and at least moderately susceptible to further erosion.

All these soils are strongly acid and low in nitrogen, phosphorus, potassium, lime, and organic matter. They may be sufficiently cherty to interfere materially with tillage or have steep slopes in excess of 25 percent. The soils absorb water readily, but many of them do not retain it well because of their strong slopes and light-textured open porous nature. On many of the soils plants are injured by even moderate droughts. Although these soils have only fair physical properties at best, they are of considerable agricultural importance because of their large acreage.

Management requirements.—The requirements for proper use and management of the soils of group 12 are variable. In a few places it may be necessary and advisable to use them for growing tilled crops, whereas in others, local conditions may make their use for forest more suitable. In general they are best used for pasture, and their management requirements are those for pasture.

A mixture of grasses and legumes is best suited to these soils. Timothy, redtop, orchard grass, bluegrass, white clover, lespedeza, and hop clover can be expected to do fairly well. To establish pastures, these soils should be plowed and seeded to the desired mixture. Lime, phosphorus, and probably potash are needed in moderate quantities at relatively frequent intervals to obtain good stands and satisfactory yields of grasses and legumes. Scattering of droppings will be partly effective in maintaining the supply of potassium, but additional amounts from fertilizer will probably be needed on many of the soils.

Soil moisture conditions are relatively poor because of the rapid rate of runoff and the permeability of the subsoil. Where the soils are eroded, the large gullies can be stabilized by the use of check dams and suitable vegetation. Grazing should be very carefully controlled during periods of drought, because injury to the pasture stands would lead to denudation of the soil and greatly increased susceptibility to erosion. As on other pasture soils, the control of weeds will be largely accomplished through the use of correct amendments and properly controlled grazing; but clipping a few times each year may be advisable. There is a large quantity of chert on many of these soils, and

it may so inhibit movement of cattle over the land that use for pasture is not feasible, even though fair to good stands can be obtained.

Where the need for land makes necessary the use of these soils for crops, management requirements will be exacting. The soils are suited to long rotations consisting chiefly of close-growing small grains and hay crops; but if they are carefully managed otherwise, row crops can be grown once in 7 years. Corn, wheat, oats, lespedeza, red clover, timothy, and redtop will produce fairly well if properly managed. Fruit trees do fairly well on similar soils in other Tennessee counties, and they would probably be successful in the Norris area if there were ready markets to make production desirable.

All crops on the soils of this group need complete fertilizer. Small to moderate applications to meet the needs of the individual soils are preferable to large applications once or twice during the rotation. Lime is also needed. One fairly heavy application preceding the hay crop is probably adequate, although additional quantities may be needed during the course of the rotation, especially to maintain good stands of legumes.

The selection of suitable crops, the use of proper rotations, and the application of needed amendments will be largely effective in controlling erosion, but some special practices for this purpose are probably needed in most areas. Contour tillage is effective in conserving moisture and soil material in practically all places. On the longer slopes strip cropping is an effective method of water control. In some places hillside ditches may be useful in diverting runoff from fields, but in most places they are of questionable value. The ditches must be carefully planned, constructed, and maintained to be effective.

MANAGEMENT GROUP 13

Management group 13 includes all of the Fifth-class soils. They are very poorly suited to crops and poorly to very poorly suited to pasture. All are low to very low in productivity, very poor in workability, and poor to very poor in conservability. Each has unfavorable soil properties, as steep slope, chertiness, stoniness, erosion, strong acidity, poverty in essential plant nutrients, or some combination of these, that makes it unsuitable for use in the present agriculture of the area. The soils are therefore limited to forest use, even though they are less productive of trees than soils of most of the other groups.

Management requirements.—Because the soils of group 13 are chiefly in forest and are considered physically best suited to that use, their management requirements are those for forest. Forest management is described in detail in the section on Forests. On some farms extreme need for land may necessitate the use of areas of some of these soils for growing crops or pasture, even though they are not well suited to such use. In such places management requirements will be similar to those described for group 12.

PUBLICATIONS RELATING TO USE AND MANAGEMENT OF SOILS AND CROPS OF TENNESSEE

The Tennessee Agricultural Experiment Station, the Tennessee College of Agriculture Extension Service, and the University of Tennessee have issued many publications that relate to the soils and

crops of the State. A selected list of these and other publications follows:

Tennessee Agricultural Experiment Station bulletins:

- | | |
|--|---|
| 78. The Soils of Tennessee: Their Chemical Composition and Fertilizer Requirements | 142. The Effects of Various Legumes on the Yield of Corn |
| 136. The Oat Crop | 149. Fertilizers and Manure for Corn |
| 141. The Comparative Values of Different Phosphates | 176. A New Explanation of What Happens to Superphosphate in Limed Soils |

Tennessee Agricultural Experiment Station circulars:

- | | |
|--|--|
| 6. The Value of Farmyard Manure | 34. Increasing the Profits from Phosphates for Tennessee Soils |
| 10. A Select List of Varieties of Farm Crops | 45. Balbo Rye |
| 11. Rates and Dates of Planting for Tennessee Farm and Garden Crops | 49. Korean Lespedeza |
| 33. The Effect of Certain Soil Conditions on the Yield and Quality of Burley Tobacco | 52. Rye for Pasture and Seed in Tennessee |
| | 60. Fertilizers for Tennessee Soils |
| | 65. The Effect of Shade on Pasture |

Tennessee College of Agriculture Extension Service publications:

- | | |
|---|--|
| 133. Lime and Prosperity of the Farm | 213. Alfalfa in the Tennessee Farm Program |
| 144. The Farm Woodland in Tennessee | 214. Small Grain in Contour Furrows on Lespedeza Sod |
| 161. Burley Tobacco Culture | 216. Making High Quality Hay |
| 188. Winter Cover Crops for Pasture and Soil Conservation | 217. A Pasture Program for Tennessee Farms |
| 197. A Land Use and Soil Management Program for Tennessee | 218. Farming Terraced Fields |
| 208. Lime, Phosphate and Legumes in the 1937 Agricultural Conservation Program | 219. Plowing for Terrace Maintenance |
| 209. The Place of Terraces in Tennessee Agriculture | 227. Field Mechanics of Terracing |
| 210. Increasing Farm Returns; Some Principles of Farm Organization and Management | 228. Terrace Outlet Waterways |
| | 233. How to Build and Conserve Your Soil with the Aid of the AAA |
| | 234. Conservation and Use of Manure on Tennessee Farms |
| | 245. Planning the Farm Layout and Cropping System |

Tennessee College of Agriculture Extension Service leaflet:

19. Soybean Seed Production in Tennessee

College of Agriculture, University of Tennessee bulletins:

- | | |
|--|---|
| 5. Determining Soil Types on Tennessee Farms | 6. Getting Acquainted with the Origin and Nature of Farm Soils in Tennessee |
|--|---|

ESTIMATED YIELDS

The estimated acre yields for the soils of the Norris area are given in table 6, which shows the yields of crops on the soils of the area that may be expected under two different levels of management. Yield estimates of this kind may assist in estimating land values and potential production capacities of soil areas and farms.

TABLE 6.—Estimated average acre yields of principal crops under 2 levels of management on soils of the Norris area, Tennessee

[In columns A—yields under common practices of management; in columns B—yields under good practices of management; blank spaces indicate soil is unsuitable and crop is not commonly grown]

Soils	Corn		Wheat		Oats		Barley		Burley tobacco		Timothy and clover		Alfalfa		Lespedeza		Sorghum		Potatoes		Sweet potatoes		Vegetables ¹		Permanent pasture (Cow-acres-days) ²		
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	
	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Lb.	Lb.	Tons	Tons	Tons	Tons	Tons	Tons	Gal.	Gal.	Bu.	Bu.	Bu.	Bu.					
Allen loam.....	28	43	16	23	30	43	22	32			1.4	2.0	2.4	3.4	1.0	1.5	65	80	130	160	112	135	60	70	60	90	
Alluvial soils, undifferentiated.....	10	15									(?)	(?)			.4	.6	50	65							60	80	
Armuchee silt loam:																											
Hilly phase.....	15	25	10	18	12	30	12	20			.5	.9	.8	2.0	.5	1.3	30	50	60	80	45	65	30	40	60	95	
Steep phase.....	(?)	(?)									.4	.6	(?)	(?)	.4	.5									55	75	
Bolton silt loam:																											
Hilly phase.....	25	35	10	15	22	33	12	22	800	1,125	1.0	1.4	1.8	2.8	1.0	1.3	60	70	90	140	90	115	50	60	55	80	
Rolling phase.....	28	40	13	20	25	40	18	30	1,000	1,300	1.2	1.6	2.0	3.2	1.0	1.4	65	80	110	170	85	135	75	90	60	95	
Steep phase.....	(?)	(?)									.8	1.0	(?)	(?)	.7	.9									45	80	
Capshaw silt loam.....	28	40	13	22	28	42	18	30	1,000	1,300	1.3	1.6	1.6	2.0	1.0	1.4	65	80	100	150	90	120	80	90	60	90	
Caylor silt loam:																											
Rolling phase.....	30	43	18	23	30	45	24	36	1,200	1,500	1.5	1.8	2.8	3.6	1.3	1.5	80	90	150	180	113	128	75	90	80	100	
Undula'ing phase.....	40	55	20	28	35	55	28	40	1,500	1,800	1.8	2.0	3.2	4.0	1.5	1.8	80	100	160	200	120	150	90	100	90	110	
Claborn silt loam:																											
Hilly phase.....	20	32	10	15	18	32	12	22	700	1,000	.9	1.3	1.6	2.6	.9	1.2	50	60	80	120	75	110	45	55	50	80	
Rolling phase.....	25	38	13	20	25	40	16	30	975	1,275	1.1	1.5	2.0	3.0	1.0	1.3	60	75	100	160	80	125	70	85	60	90	
Steep phase.....	(?)	(?)									.6	.8	(?)	(?)	.7	.8									35	50	
Clarksville cherty silt loam:																											
Hilly phase.....	13	20	8	12	10	20	10	14	500	700	.4	.7	.6	1.2	.4	.8	30	35	50	80	50	70	30	50	25	45	
Rolling phase.....	15	25	9	13	13	25	12	20	700	900	.6	.8	1.0	1.5	.5	.9	40	50	60	100	60	90	40	60	30	60	
Steep phase.....	(?)	(?)									.4	.6	(?)	(?)	.4	.5									20	35	
Clarksville loam, rolling phase.....	18	28	9	12	13	24	12	20	600	900	.7	1.2	1.0	1.6	.6	1.0	40	60	80	100	60	90	35	50	30	60	
Colbert silt loam, rolling deep phase.....	18	30	10	16	20	30	15	25	700	1,000	1.0	1.5	1.8	3.0	.8	1.2	50	65	70	110					55	80	
Colbert silty clay loam, eroded rolling phase.....	15	23	8	10	18	25	10	16			.6	.9	1.4	2.2	.6	1.0	35	40							40	65	
Cumberland silt loam.....	40	50	18	28	33	50	28	36	1,500	1,800	1.6	2.0	3.6	4.2	1.3	1.7	70	85	160	190	120	150	90	100	90	110	
Dewey silt loam, undulating phase.....	40	50	19	27	33	50	26	36	1,500	1,800	1.6	2.0	3.6	4.2	1.3	1.7	70	85	160	190	120	150	90	100	90	110	
Dewey silty clay loam:																											
Eroded hilly phase.....	25	35	14	18	23	40	16	24	1,000	1,400	1.2	1.5	2.4	3.0	.9	1.3	50	60	110	140	90	105	40	50	50	90	
Eroded rolling phase.....	30	45	14	20	30	50	20	32	1,100	1,500	1.3	1.7	2.8	3.6	1.1	1.5	65	75	130	160	113	135	70	80	75	100	
Eroded steep phase.....											.6	.9	1.8	2.4	.5	.8									40	70	

See footnotes at end of table.

In columns A, the yields given are those to be expected on the different soils under prevailing practices of soil management. The present use and management practices described in the section on Soils under the names of the individual soils indicate the general features of prevailing management under which yields in columns A can be expected.

The yields given in columns A are based largely on observations made by members of the soil survey party; on information obtained by interviews with farmers and other agricultural workers who have had experience with the soils and crops of the area; and on comparisons with yield tables for other counties in Tennessee with similar soils. Specific crop-yield data by soil types are not generally available, but it is believed that the summation of local experience will give fairly reliable estimates of the yields that can be expected under the management commonly practiced. Yield information of any kind is very scarce for some crops. This is especially true of the yields of sorghum, vegetables, potatoes, and sweetpotatoes, and the carrying capacity of pastures.

In column B the crop yields that can be expected under good management are given. Good management refers to the proper choice and rotation of crops; the correct use of commercial fertilizer, lime, and manure; proper tillage methods; the return of organic matter to the soil; the use of mechanical means for water control; the maintenance of productivity and improvement of workability; and the conservation of soil material, plant nutrients, and soil moisture.

Although knowledge of what constitutes good management of all of the soils is far from complete, some of the deficiencies of the soils and the means to correct them are known with reasonable certainty. Some of the requirements for good management of the soils are presented in the section on Soils under the discussions of the individual soil types and phases, and in the section on Soil Use and Management.

The requirements of different crops on the same soil as well as the same crop on different soils may vary. The level of good management for the soils on a particular farm depends not only on the character of the soils, but on the amount and distribution of the various soils on the farm; the combination of enterprises in the farm business; the location of the farm relative to markets and other facilities; prices; and perhaps other factors peculiar to the farm. The requirements for good management of any particular soil therefore cannot be rigidly defined, because these requirements vary among the individual farms. Furthermore, there is insufficient specific information on which to base such definitions. Precise definitions of good management are therefore not presented in this report.

The expectable yields in columns B are based largely on estimates by men who have had experience with the soils and crops. These estimates are based on the known deficiencies of the soil and the increased crop yields that can be expected when these deficiencies are corrected within practical limits. Crop yields cannot be precisely predicted because of the possible development of new practices and varieties, the inadequacy of data on actual yields, and the variation in what constitutes good management.

The yields listed in columns B, when compared to those in columns A, give some idea of the responses that can be expected from good man-

agement. They may be used as production goals that might be attained by feasibly good management practices. The means of attaining this goal may vary somewhat, but in general it consists of some combination of good management practices. More intensive management will bring profitable increases in yields on practically all the soils of the Norris area.

SOIL ASSOCIATIONS

Soil associations may be defined either as a group of soils occurring together in a characteristic pattern or as an area definable as to the kind, proportion, and distribution of soils within it. A soil association may consist of only a few or of many soils. The soils may all be similar or they may represent many differing types. In each soil association, however, there is a certain uniformity of soil pattern.

Like other simplified or generalized soil maps, a map of soil association areas gives a picture of larger areas having common problems. Soil association maps promise to be useful in regional studies of agricultural production or of changes and adjustments that may be necessary in such production.

Eleven soil associations have been recognized in the Norris area. They tend to follow exposures of geologic formations and extend roughly northeast-southwest across the area. These associations are defined and described in the following pages in terms of the proportions and patterns of the different soils. Their present and potential uses in the agriculture of the area are also discussed briefly.

MUSKINGUM-JEFFERSON-ARMUCHEE ASSOCIATION

The Muskingum-Jefferson-Armuchee association is in one large area on the Cumberland Mountain escarpment and on Clinch Mountain. It is underlain chiefly by acid sandstone and conglomerate, but limestone and shale are under part of the association on the lower slopes. The rock formations are generally sharply tilted. Slopes are steep to very steep, and outcrops of rock are characteristic, as are large bluffs of sandstone and conglomerate, especially near the crest of the escarpment.

Muskingum soils constitute half or more of the total area of this association. They are chiefly on the upper escarpment slopes. Armuchee soils in small- to medium-sized areas are at the foot of the escarpment. Some areas of Limestone rockland (rough) are in many places on the lower mountain slopes. The Jefferson soil is on the colluvial deposits at the base of the escarpment and along the small drains in the association area. All the land types and soils included in this association except some of the Armuchee soils and the Jefferson soil are very poorly suited to either crops or pasture, and are properly considered forest land.

Practically all of this association is now under second-growth forest, consisting chiefly of pine mixed with such hardwoods as post, red, and black oaks, blackgum, and sourwood. Most of the area is included in farms centered in the adjacent limestone valley. The better classes of timber have been harvested and the present stand consists chiefly of young, cull, and weed trees.

Inasmuch as nearly all the soils included in this association are entirely unsuited to use as either crop or pasture land, they are limited to forest use, even though they are less productive of trees than are the soils in many other associations. Soil use and management are therefore concerned chiefly with the development and use of forests.

TALBOTT-CAYLOR-STONY LAND ASSOCIATION

The association of Talbott and Caylor soils and stony land types occupies practically all of Powell Valley. It lies as a rolling valley land below the precipitous Cumberland escarpment. The escarpment is along the northwestern edge and the hilly to steep cherty ridge lands of the Clarksville-Fullerton-Claiborne (hilly to steep) association are along the southeastern edge. The conformation is irregular because of the many shallow sinks and the shallow valleys of small streams crossing the valley from the Cumberland Mountains. The entire association area is underlain by relatively high-grade limestone, and many of the soils are derived from residuum weathered from this rock, although there are extensive areas of colluvium and stream alluvium from which many of the more productive soils are derived.

The soil pattern is complex. Talbott, Caylor, and Rolling and Smooth stony lands (Talbott soil material) are most extensive in the association, but there are notable acreages of the Armuchee, Allen, and Jefferson soils. The Talbott and Caylor soils and the stony land types are distributed through the central parts of the area; and the Allen and Jefferson soils are on somewhat higher lying colluvial foot slopes near the Cumberland escarpment. Most of the Armuchee soils are directly adjacent to the escarpment on strong slopes. There are some areas of Dewey soils intermingled with the Talbott and Caylor soils and stony land types. Ooltewah, Lindside, and Sequatchie soils are on the alluvium in the depressions, sinks, and low-lying stream terraces and first bottoms.

Practically all the soils included in this association are suited to farming. About 60 percent of them are suited to crops requiring tillage, and practically all the rest is suited to pasture. All of the Talbott, Caylor, Dewey, Allen, Jefferson, Sequatchie, Ooltewah, and Lindside soils are fair to excellent cropland; whereas the Talbott and Dewey soils on hilly and steep slopes, the Smooth and Rolling stony lands (Talbott soil material), and the Armuchee soils are not well suited to crops requiring tillage but are fair to good for pasture.

This association supports one of the most prosperous agricultural communities in the area. Most of the farms are medium in size, have considerable diversity of enterprises, and are classified as general farms. Corn, lespedeza, wheat, and burley tobacco are the chief crops on most farms. Minor crops include red clover, alfalfa, soybeans, cowpeas, oats, barley, and fruits and vegetables for home consumption. Small herds of beef cattle are on many farms, and poultry, hogs, and dairy cows for home use are on practically all farms.

Land use is fairly well adjusted to the physical suitability of the soils in the association, but management is usually not at a level that will maintain or increase their productivity. A large part of the soils are cleared and used for crops and pasture, but small areas of woodland are on most farms, chiefly on the stonier and more strongly sloping

uplands and poorly drained bottom lands. Among the improved management practices needed on most farms are better selection and rotation of crops, use of more lime and commercial fertilizer, and better control and utilization of water on the land. Most pastures can be improved by the use of more amendments, better control of grazing, and improvement of composition of pasture mixtures by eradicating weeds and seeding with the higher yielding more nutritious grasses and legumes.

CLARKSVILLE-FULLERTON-CLAIBORNE (HILLY TO STEEP) ASSOCIATION

The Clarksville-Fullerton-Claiborne (hilly to steep) association is characterized by a hilly to steep surface and represents the extensive rougher part of the cherty ridge area. Clarksville and Fullerton soils predominate, but in many places Claiborne soils make up a considerable part. A small acreage of Bolton soils is widely distributed, and very small acreages of Greendale, Roane, and Lindsides soils are in the depressions and along the drainageways. Most of the ridge crests are occupied by narrow irregular strips of smooth to rolling Fullerton and Claiborne soils. The largest area is a broad irregular belt along the Powell River, and that includes the Central Peninsula between the Powell and the Clinch Rivers. Other large areas are on Chestnut and Hinds Ridges.

Chiefly because of the predominantly steep slopes and comparatively low fertility of most of the soils, this association is of relatively low agricultural productivity. Probably 65 percent of the acreage is poorly suited to either crops or pasture, and only about 15 percent is physically suitable for crops requiring tillage. A large part of the aggregate area of Fifth-class soils in this association is under hardwood forest, and the cleared and cultivated areas are confined chiefly to the smoother parts on the narrow irregular ridge tops.

Many farms are of the subsistence type; they vary considerably in size but most of them do not have enough soils suited to crops and pasture to serve as farms of the general type. Vegetables and fruits for home consumption, burley tobacco, hay, and wheat are the more important crops. One or two dairy cows, a few pigs, and small flocks of chickens are the chief livestock. Present land use is fairly well adjusted to the physical use suitability, although not ideally so, as many small areas of steep and eroded soils are used for crops or pasture that should be used less intensively. Soil management is not at a high level. The readjustment needed to obtain optimum production involves better selection and rotation of crops, the use of lime and more adequate fertilization, and more effective control of runoff.

CLARKSVILLE-FULLERTON-CLAIBORNE (ROLLING TO HILLY) ASSOCIATION

The Clarksville-Fullerton-Claiborne (rolling to hilly) association, including the smoother parts of the cherty ridge area, has the relief its name indicates; and surface drainage is commonly to sinkholes. Fullerton and Claiborne soils are more extensive than in the Clarksville-Fullerton-Claiborne (hilly to steep) association. The proportionate area of Greendale soils is also greater, and Bolton soils are

common in places. Small irregular tracts of this association are distributed throughout the cherty ridge area and are largely surrounded and somewhat dissected by tracts of the steeper Clarksville-Fullerton-Claiborne association.

The association represents some of the better agricultural lands of the cherty ridge area. About 80 percent of the land is suited to pasture, and about 20 percent is fair to very good cropland.

Farms of this association are chiefly of the small general type, although there are also many subsistence farms. Farm income is derived from the sale of tobacco, other field crops, and a few hogs and cattle, and from consumption of farm produce on the farms. Tobacco, corn, wheat, and hay are the chief field crops. Livestock on most farms include a small number of hogs, small- to medium-sized flocks of chickens, a few dairy cows, and in many places small numbers of beef cattle.

Farms range in size from small to medium and generally include a complex pattern of soils suited to crops, pasture, and forest (pl. 5, *A*). Land use and management are fairly well but not ideally adjusted to the physical suitability of the soils. The use of lime and larger quantities of commercial fertilizer is needed to obtain optimum yields of crops and pasture. Rotation of crops and better utilization of soil moisture are other practices needed on croplands. If the soils better suited physically to crops and pasture were more intensively managed, many small areas of steep, cherty, and stony soils now cleared and in pasture or crops could well be abandoned to forest.

FULLERTON-CLAIBORNE-BOLTON ASSOCIATION

The Fullerton-Claiborne-Bolton association occupies Copper Ridge and small irregular areas on other cherty ridges. Fullerton and Claiborne soils predominate, but in many places, Bolton and Clarksville soils are of considerable extent. Greendale, Roane, and Lindsides soils are in depressions and along the drainageways. Most slopes range from about 12 to 45 percent. The soils are moderate to low in fertility and to a large extent moderately cherty. This association has a relief similar to the Clarksville-Fullerton-Claiborne (hilly to steep) association but differs in having a larger proportionate acreage of the more productive Claiborne and Bolton soils.

Most farms are of the subsistence or small general-farming type and vary considerably in size (pl. 5, *B*). Corn, small grains, hay, and tobacco are the chief crops grown. A moderately long rotation on the soils suited to tillage and permanent pasture on the extensive Fourth-class soils are desirable. The steepest areas probably should remain in forest.

STONY LAND-TALBOTT-CAYLOR ASSOCIATION

The extensive association of stony lands and Talbott and Caylor soils is widely distributed. It occupies smooth to rolling limestone valleys (pl. 5, *C*) and differs from the Talbott-Caylor-stony land association chiefly in consisting largely of stony land and in having only a minor acreage of Talbott, Caylor, and Colbert soils. In some places there are small areas of Dewey soils, which like the Talbott soils, are associated with the predominant Smooth and Rolling stony lands (Tal-

bott soil material). Lindside soils are in narrow strips along the larger streams, and there are small areas of Limestone rockland intermixed with the stony land types.

Two-thirds or more of the land in this association is not well suited to crops. This part is used chiefly for pasture because of its stoniness. The acreage well suited to crops is chiefly of the Talbott, Caylor, and Dewey soils.

Raising beef cattle is the chief enterprise on many farms. Most of the farms, however, have sufficient diversity of enterprise to permit their classification as general farms. Corn, hay, and pasture are the chief crops, although burley tobacco is an important cash crop. Wheat and fruits and vegetables for home use are other common crops. Most farms are fairly large, consisting of a relatively large acreage of soils suited only to pasture and a small to moderate acreage suited to crops. There are a few subsistence farms.

Land use is generally well adjusted to the soils. Soil management, however, is considerably below the level considered feasible for the present agriculture. The use of lime and fertilizer, control of grazing, and weed clipping are necessary. Management requirements for the production of crops on the soils suited to tillage include a moderately long systematic rotation, use of lime and adequate fertilizer, the growing of winter cover crops, and better control of runoff.

LEHEW ASSOCIATION

The Lehew association consists largely of steep soils that are shallow to bedrock and low in fertility. Lehew soils greatly predominate, but there are small areas of Montevallo and Armuchee and very small bodies of Leadvale soils lying as narrow strips along a few of the drainageways. The greater part of the association lies on Big Ridge, Comb Ridge, and Lone Mountain.

Little of the association is suited to crops or pasture. The small area of Armuchee soils is fair to good pasture land, and the very small acreage of Leadvale soils is fair to good cropland. There are few if any farmsteads, but some tracts are cleared along the drainageways and farmed in connection with fields in adjoining associations that are better suited to crops and pasture. Cut-over forest occupies a large part of the aggregate area and in general the association is best used for forest.

MONTEVALLO-LEADVALE-ARMUCHEE ASSOCIATION

The Montevallo-Leadvale-Armuchee association is in shaly valley areas that have a predominantly hilly to steep surface. Most of the soils are shallow to bedrock and of low to medium fertility. Hilly and steep Montevallo soils occupy 60 to 70 percent of the area. The rest consists chiefly of Armuchee, Leadvale, Pope, and Philo soils, but a small acreage of Rolling stony land (Talbott soil material) is included. Most of the association is in Hinds and Little Valleys (pl. 6, A).

The percentage of land suitable for crops requiring tillage varies notably from place to place but in general is low. About 20 percent of the area is suited to crops. Less than half of the remaining acreage is suited to pasture, and the rest, only to forest.

From 45 to 60 percent of the area is cleared. This includes practically all of the Leadvale, Pope, and Philo soils and in general much of the less steep stony land and Montevallo and Armuchee soils. A large part of the strongly sloping to steep Montevallo and Armuchee soils that is poorly suited to crops has been cultivated.

ARMUCHEE-SEQUOIA ASSOCIATION

The Armuchee-Sequoia association is in the southeastern part of the area, chiefly in Texas Valley. It occupies a small valley and a belt of hilly and steep ridges on either side. The underlying rock is chiefly interbedded limestone and shale, and most of the soils are derived from residuum weathered from these materials.

The Armuchee soils, Rough stony land (Fullerton soil material), and Sequoia soils constitute the chief part of the association. The Sequoia soils are on the low rolling uplands of the valley floor, and the Armuchee soils and Rough stony land (Fullerton soil material) are on the hilly and steep adjacent slopes. Leadvale and Philo soils occupy a smaller acreage. Less than half of the soils are suited to crops requiring tillage, and most of the rest, to pasture. The tillable soils are confined to the smooth valleys, and the pasture-suited soils are mostly on the adjacent hilly and steep slopes. Some of these steeper soils are best used for forest.

Most farms on this association are of the small general or subsistence types. Corn, tobacco, and hay are the chief crops, and hogs, poultry, and a few dairy cows are the chief livestock. Soil uses are reasonably well adjusted, but management practices are at a fairly low level. Use of more soil admendments and better control and utilization of water on the land are needed on both cropland and pasture. Better selection and rotation of crops will help to increase the productivity of the cropland.

DEWEY-FULLERTON-CLAIBORNE ASSOCIATION

The rolling to hilly Dewey-Fullerton-Claiborne association occupies a valley and a belt of hilly or steep ridges on either side. Dewey soils are largely confined to the valley, and the Fullerton and Claiborne soils are on the ridge slopes. A few small areas of Emory soils are on the colluvial foot slopes. Most of the first-bottom soils are covered by the waters of the Norris Reservoir. About half the total acreage is suited to crops requiring tillage, and most of the rest, to pasture. Some of the steeper slopes are best used for forest. This association is in two small areas, one at the junction of the Powell and the Clinch Rivers and the other in the vicinity of Leadmine Bend Creek.

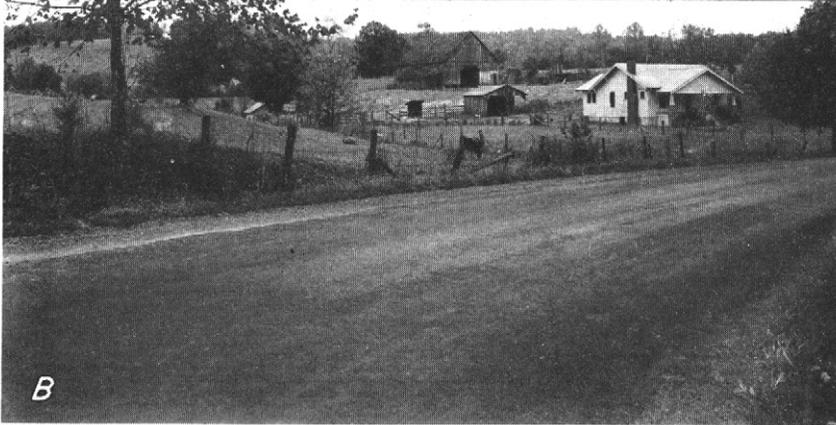
Most of the farms in this association are of the small general or subsistence types. Corn, tobacco, and hay are the chief crops; and hogs, poultry, and a few cattle are the main livestock. Use of more soil amendments and better control and utilization of water on the land are needed on both cropland and pasture. Better selection and rotation of crops will aid in increasing the productivity of the cropland.

SEQUOIA-ARMUCHEE ASSOCIATION

The Sequoia-Armuchee association occupies a smooth valley and a narrow belt of hilly and steep ridges on either side. The underlying



- A, Small to medium-sized farms in the Clarksville-Fullerton-Claiborne (rolling to hilly) association include a complex pattern of soils suited to crops, pasture, and forest.
- B, Substantial but moderate home and sufficient outbuilding space for the tobacco crop, work stock, a few cows, and a part of the feed crops on the Fullerton-Claiborne-Bolton association.
- C, Characteristic home and buildings on the better farms of the Stony land-Talbott-Caylor association; Fullerton soils in the background.



- A, View across a valley occupied by the Montevallo-Leadvale-Armuchee association to a steep, irregular ridge of Lelew soils.
- B, Good home and moderate accommodations for crop storage and livestock on one of the better farms in the Sequoia-Armuchee association.
- C, Small portable sawmills handle practically all the lumber produced. Nearly 30 percent of the forest acreage of Union County is occupied by hardwoods and most of the rest by mixed hardwoods and pine.

rock is chiefly interbedded limestone and shale, and most of the soils are derived from residuum weathered from these materials. The association is chiefly in Raccoon Valley.

The Sequoia soils are on about half of this association, and Armuchee soils and Rough stony land (Fullerton soil material) are on most of the rest, although there are significant acreages of Leadvale and Philo soils. The soils on the smooth valley uplands, which make up about 50 to 60 percent of the total, are suited to crops requiring tillage. Those on the hilly or steep ridge slopes are suited to pasture.

The farms of this area are chiefly of the small general type, but a considerable number are of the subsistence type (pl. 6, *B*). Most of this association is cleared and used for crops or pasture, the chief crops being corn, small grain, hay, and tobacco. Although soil uses are fairly well adjusted, management practices are at a fairly low level.

FORESTS¹²

The first settlers found this area an unbroken forest. The country abounded with game, such as elk, buffalo, bear, deer, and turkey and many smaller animals (4). The land along the Powell River was exceedingly rich with buckeye 4 feet in diameter, poplar 9 feet through, and thick cane on the mountainside (21).

About 50 percent of the land area of Union County is in forest; and of this, 36 percent is farm woodland, 26 percent nonfarm forest, and 38 percent public forest.¹³ The public forest is largely between the Clinch and the Powell Rivers.

The timber-producing areas divided by forest types are 30 percent upland hardwoods, 8 percent oak-chestnut, 56 percent yellow pine-hardwoods, 4 percent cedar-hardwoods, and 2 percent yellow pine.¹⁴ As a further indication of the size and stage of development of the timber in the county, 42 percent of the total area in forest is classified as saw timber, 50 percent as cordwood, and 8 percent as below cordwood.

There is some correlation between soil associations and broad forest types, but this is not perfect in many places. The upland hardwoods type is associated with the Clarksville-Fullerton-Claiborne (hilly to steep) association on Hinds Ridge and with the Fullerton-Claiborne-Bolton association on Copper Ridge. The oak-chestnut type is not restricted to any one soil association but is on the Clarksville-Fullerton-Claiborne (hilly to steep), Clarksville-Fullerton-Claiborne (rolling to hilly), and Lelew associations, primarily on southern and southwestern exposures. The yellow pine-hardwoods is the most extensive forest type in the Norris area and is associated chiefly with soils of the Clarksville, Fullerton, and Claiborne series. The cedar-hardwoods type is confined largely to the Talbott-Caylor-stony land and the Stony land-Talbott-Caylor associations. The yellow pine type is restricted to the area east of Maynardville and occurs largely on the Lelew association.

¹² Prepared by G. B. Shivery, extension forester, University of Tennessee.

¹³ TENNESSEE VALLEY AUTHORITY. FORESTRY DATA FOR THE TENNESSEE VALLEY, PART 3. Tenn. Val. Authority, Dept. Forestry Relat. Forestry Bul. 5, 25 pp., illus. 1942. [Processed.]

¹⁴ TENNESSEE VALLEY AUTHORITY. FORESTRY DATA FOR THE TENNESSEE VALLEY, PART 1. Tenn. Val. Authority, Dept. Forestry Relat. Forestry Bul. 3, 155 pp., illus. 1941. [Processed.]

The soils of the Fullerton-Claiborne-Bolton association on Copper Ridge and of the Clarkesville-Fullerton-Claiborne (hilly to steep) association on Hinds Ridge are, to a marked degree, forested with such characteristic upland hardwood species as chestnut, black, Northern red, Southern red, post, and scarlet oaks, pignut hickory, tuliptree, blackgum, basswood, and dogwood, along with varying percentages of shortleaf pine, Virginia pine, or both. Soil types of the Clarkesville-Fullerton-Claiborne (hilly to steep) association between the Clinch and the Powell Rivers maintain a growth of mixed yellow pine and hardwoods in which the pine makes up between 25 and 75 percent of the total stand. Old abandoned areas of Bolton soils have reforested by natural means to stands of pure shortleaf pine, and in some places these are being cut and the land placed in cultivation a second time.

Clarkesville cherty silt loam, steep phase, is practically all in forest and is best retained in forest because of steep slope, chertiness, and low fertility. Lebew fine sandy loam, steep phase, largely remains in forest and the small areas cleared in the past have naturally reseeded to stands of shortleaf pine. This phase is one of the most extensive soils in forest. It is in large continuous areas, particularly on Pine and Comb Ridges, and is covered predominantly by the yellow pine-hardwood forest type. Land types such as Limestone rockland (rolling) and Limestone rockland (rough) support a poor forest growth largely of redcedar but including a variety of native hardwoods. Observation of past clearing on Montevallo shaly silt loam, rolling phase, indicates that this soil is best used for forest. Much of it remains in forest, and where cleared, it tends to restock naturally with shortleaf or Virginia pine if seed trees are present.

Muskingum stony fine sandy loam, steep phase, and Muskingum stony fine sandy loam, hilly deep phase, are forested chiefly with upland hardwoods and to less degree with the oak-chestnut and the yellow pine-hardwoods forest types. Rolling stony land (Talbot soil material), now largely in pasture, may be retired in the course of time to forest, as that is the most economic land use. Rough gullied land (Talbot soil material) and Rough gullied land (Montevallo soil material) in many instances require special treatment before a forest cover can be established. The soils of the Lebew and the Muskingum-Jefferson-Armuchee associations are predominantly covered with the largest unbroken forests in the area. Considering the steep topography and the physical characteristics of these soils, they are properly used for forest land.

In 1942 there were 10 active sawmills in Union County, 6 in 1912, and 32 in 1909 (2, 17) (pl. 6, C). In 1942 the production of lumber was 472 thousand board feet of pine and 355 thousand of hardwood. No pine pulpwood was produced in 1941, but 500 cords of hardwood pulpwood and 5,700 cords of chestnut extract wood were produced.¹⁵

A part of the forests in the Norris area are burned annually. Most of these fires are caused by carelessness in burning brush, but a few are the result of incendiarism. Fire control is necessary, not only for satisfactory forest production but also for the maintenance of maximum soil porosity and erosion control. Control of grazing is neces-

¹⁵ LOTTI, T., and EVANS, J. C. VIRGINIA'S FOREST. U. S. Dept. Agr. Forest Service Forest Survey Release 11, iii+13+62 pp., illus. 1942. [Processed.]

sary for similar reasons. Indiana experiments (7) prove that grazing does not pay, because woodland grazing under intensities of 2, 4, or 6 acres allowed per animal unit without supplementary feeding resulted in serious deterioration of the animals over a 6-month season. The timber-producing capacity is gradually destroyed by repeated browsing, and there is finally a curtailment of tree reproduction that prevents natural regeneration of the stand. Compaction of the soil, disturbance of humus, and resulting interference with soil porosity lessen water absorption.

A radical change must be made to halt the progressive deterioration of forest resources. A much greater value must be placed on the potential crop or saw-timber tree. The cut-over woodland and forest now contain much cull timber that hinders the development of these potential crop trees. Farm woodlands can be materially improved by reserving the vigorous trees and using the cull trees for fuel and other minor farm needs or by cutting them for pulpwood or chemical wood. Such improvement includes systematic cutting and use of crooked, short bushy-topped, unsound, or slow-growing trees and reserving the straight, tall, well-crowned trees, free from defect, for growth into final crop timber.

Second-growth stands on eroded land consist largely of shortleaf pine with Virginia pine intermixed (pl. 7). Virginia pine is a more prolific producer of seed than shortleaf pine and also has the advantage of being able to utilize drier and less favorable sites. Shortleaf pines seeded by natural means display a remarkable ability to establish themselves on sites where the heavy-textured subsoil is exposed, provided seed trees are present so that proper dissemination can be effected. Judicious thinning during the early stages improves the stands by increasing the growth and decreasing the risk of damage from the Southern pine beetle.

Planting forest trees is occasionally necessary, particularly on the severely eroded Fourth- and Fifth-class soils. Every location presents a specific problem. Advance preparation is necessary to success, and it includes such measures as breaking and mulching galled areas, building simple low check dams of brush in gullies, and plowing contour furrows. Preparation of severely gullied areas usually entails a great deal of work, and planting of such land has been facilitated by labor supplied from camps operated jointly by the Tennessee Valley Authority and the Civilian Conservation Corps. As a result of this activity, a total of 233 projects involving 1,016 acres in Union County and 214 projects involving 824 acres in Campbell County were reforested with seedling stock of black locust and shortleaf pine from 1936 to 1941.¹⁶ On areas involving less advance preparation, the landowner is encouraged to do the entire job, and he uses forest tree seedlings provided without cost by the Tennessee Valley Authority. Under this arrangement, through the medium of county agricultural agents, a total of 7 projects involving 26 acres were successfully completed in the two counties from 1936 to 1941.

Experiments in planting forest trees under a variety of conditions were begun as early as 1938 and are under way on the Clarksville-Fullerton-Claiborne (hilly to steep) association. The White Hollow

¹⁶ Information from the Department of Forestry Relations, Tennessee Valley Authority.

Demonstration Forest Plantings, the largest experimental area, contains 772 acres of plantations on a 2,800-acre tract (13, 14).¹⁷

Preliminary experimental plantings are also in the Davis Creek Forest Experimental area. The plantations of shortleaf pine, white pine, and yellow-poplar, as well as those of shortleaf pine-yellow-poplar mixture, white pine-yellow-poplar mixture, and shortleaf pine-white pine mixture, show successful progress. The results so far observed reemphasize the extreme importance of the choice of species and mixtures on the basis of such features as soil depth, topographic position, character of parent material, soil condition, and competing vegetation. An estimated 590 acres of sheet and gully eroded soils need reforestation in Union County, as well as 900 acres in Campbell County within the Tennessee River Basin.¹⁸

Of first importance in the preliminary examination of any area is the selection of pioneer species that suit the characteristics of the particular soil, including its exposure and degree of erosion. Although farmers many times specify locust on the strength of their farm needs for fence posts, pine (usually shortleaf pine) is better adapted to the severe growing conditions encountered on lands designated for forest use. Black locust does well in gullies where moist well-aerated soil material has accumulated behind simply constructed check dams. A large proportion of areas therefore need black locust for the silting basins in the gully bottoms and shortleaf pine for the eroded strips and areas between the gullies. Heavy dependence must be placed on shortleaf pine on most areas of eroded land except those where intensive land preparation and fertilization with phosphate warrant the use of black locust.

Shortleaf pine should be the principal species for use on Bolton silt loam, hilly and steep phases, and Armuchee silt loam, steep phase; but black locust can be used as an alternate under favorable conditions of preparation and exposure. White pine should receive serious consideration in any plans for reforestation of Clarksville, Fullerton, or Claiborne soils, and the regulations governing eradication of currant and gooseberry bushes should be observed.

On Rough gullied land (Talbot soil material), which presents primarily a land reclamation problem, black locust is a valuable aid along with shortleaf and Virginia pines and other selected species present on similar adjoining areas. Shortleaf pine should be used on Rough gullied land (Montevallo soil material) wherever conditions of erosion permit, and Virginia pine, where the site makes particularly difficult the establishing of a forest cover. It should be emphasized in every instance that conditions of the site rather than the desire of the landowner must be the deciding factor in selection of species, because production of trees not adapted to the situation will be unsuccessful.

Forests have important indirect benefits aside from production of wood products, especially on areas of land subject to accelerated erosion. A protective layer of forest litter absorbs the impact of the

¹⁷ UNITED STATES FOREST SERVICE. A PRELIMINARY GUIDE FOR THE REFORESTATION OF OLD FIELDS IN THE GREAT APPALACHIAN VALLEY AND ADJACENT MOUNTAIN REGIONS. Appalachian Forest Experimental Station Tech. Note 45, 6 pp. 1941. [Processed.]

¹⁸ See footnote 14, p. 141.



Second-growth stands of shortleaf pine intermixed with Virginia pine on eroded land.

falling drops of water and thereby preserves the tiny pores and channels between the soil particles as the water makes its way downward. Fungi, bacteria, and tiny animals that consume the litter and each other produce a dark-brown colloidal substance called humus. When humus is carried downward into the mineral soil by percolating water, it improves both physical structure and fertility. In addition this litter and humus have great capacity to absorb water directly. Porosity is further achieved by the channels left after the decay of dead roots. The soil-binding function of the surface roots is of course highly beneficial, the densest network of roots being found in the lower parts of well-developed litter layers.

Results obtained at the erosion station near Statesville, N. C., show a loss of only 0.002 ton of soil and 0.06 percent of rainfall from virgin woods. A companion woods plot burned twice yearly shows runoff of 11.5 percent and soil loss of 3.08 tons an acre, as compared to 0.06 percent and 0.001 ton per acre, respectively, on an unburned plot (6). Similar experiments at Zanesville, Ohio, for a 9-year period on cultivated land, pasture, and woodland show the runoff as 20.6, 13.8, and 3.2 percent, respectively, and soil loss per acre as 17.18, 0.10, and 0.01 ton (3). Both erosion control and maximum absorption therefore result from complete forest cover, because old-growth forested soil is more porous and absorbs water much more rapidly than the soil in cultivated fields. Where the forest cover is properly maintained, second-growth forested soil does not lose its porosity unless it is overgrazed or the litter is destroyed by fire (1).

MORPHOLOGY AND GENESIS OF SOILS

Soil is the product of the forces of weathering and soil development acting on the parent material deposited or accumulated by geologic agencies. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil material has accumulated and has existed since accumulation; (3) the plant and animal life in and on the soil; (4) the relief, or lay of the land; and (5) the length of time the forces of development have acted on the material. The climate, and its influence on soil and plants, depends not only on temperature, rainfall, and humidity but also on the physical characteristics of the soil or soil material and on the relief, which, in turn, strongly influences drainage, aeration, runoff, erosion, and exposure to sun and wind.

Climate and vegetation are the active factors of soil genesis. They exert their influence on the parent material and change it from an inert heterogeneous mass to a body that has a definite genetic morphology. The effects of climate and vegetation on the parent material are influenced to varying degrees by relief, as it affects such conditions as drainage, the quantity of water that percolates through the soil, the rate of natural erosion, and the vegetation that grows on the soil. The nature of parent material itself also directs the course of action of climate and vegetation. Finally, the changes require time, and age becomes a factor of soil genesis insofar as it reflects the degree of development of the soil into a body in equilibrium with its environment.

The factors of soil genesis are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effects of any one unless conditions are specified for the other four. They are so complex in their interrelations that many of the processes that take place in the development of soils are unknown.

The purpose of this section is to present the outstanding morphological characteristics of the soils of the Norris area and to relate them to the factors of soil formation. Physical and chemical data are limited for these soils, and the discussion of soil genesis and morphology is correspondingly incomplete. The first part of the section deals with the environment under which the soils exist; the second, with specific soil series and the part environment has played in determining the morphology of their soils.

GENERAL ENVIRONMENT AND MORPHOLOGY OF SOILS

The parent materials of soils of the Norris area are considered in two broad classes: (1) Materials residual from the weathering of various kinds of rock in place; and (2) materials transported by water or gravity and laid down as unconsolidated deposits of clay, silt, sand, and large rock fragments. Materials of the first class are related directly to the underlying rock from which they were derived; materials of the second class, to the soils or kinds of rock from which they fell or were washed.

The residual parent materials are from the weathering of consolidated sedimentary rock—limestone, shale, and sandstone—and many of the soils developed from them strongly reflect the properties of these materials. Geologically, the rock formations are very old. They were laid down as unconsolidated sediments and gradually converted into consolidated rock. The formations of the Cumberland Mountains are nearly level or very gently folded, whereas those of the valley area are severely folded and faulted and generally have a decided dip (8, 19, 20).

Certain soils of the area developed from residual material are generally associated with particular rock formations or parts of rock formations. Soils of the Talbott series are associated with Ordovician limestone of the Trenton, Black River, and Stones River formations.¹⁹ Dewey soils are derived from materials weathered chiefly from limestone of the Stones River formation; and Colbert soils, from materials weathered from Black River Limestone and Ottosee shale of the Ordovician system. The Bolton, Claiborne, Fullerton, and Clarksville soils are underlain by cherty and sandy dolomite or dolomitic limestone of the Copper Ridge and Beekmantown formations. Most of the Ar-muchee soils are underlain by Reedsville shale of Ordovician age, but small parts are from materials weathered from the calcareous shale of the Conasauga group, as are the soils of the Sequoia series.

The Montevallo soils are underlain chiefly by acid shale of the Conasauga group and the Rome formation of Cambrian age, but partly by Devonian rock of the Chattanooga formation. The Lebew soils are chiefly on sandstone of the Rome formation of Cambrian age, but some of them are on rock of the Juniata formation of Ordovician age.

¹⁹ See footnote 3, p. 3.

Muskingum soils in the valley section are from tilted sandstone of the Clinch and Clinton formations of Silurian age, whereas the Muskingum soils of the Cumberland Mountain section are from level-bedded to slightly folded acid sandstone and conglomerate containing thin bands of shale, silt stone, and coal of the Pennsylvanian system, largely of the Lee, Briceville, and Anderson formations.

Soils of the Allen, Tyler, Sequatchie, Pope, Philo, Jefferson, and Leadvale series are derived from transported materials that consist mainly of sandstone and shale and products of their decomposition. Soils of the Cumberland, Capshaw, Roane, Lindsie, Emory, Greendale, and Ooltewah series are derived from transported materials that consist mainly of limestone and dolomite and products of their decomposition. Soils of the Caylor series include materials transported from limestone and sandstone and shale materials.

Although a rather consistent relation exists between the kinds of parent materials and some of the properties of soils, other soil properties, especially those of regional significance from the standpoint of soil genesis, must be attributed to other factors.

The climate of the Norris area is temperate and continental. It has long warm summers, short mild winters, and relatively high rainfall. The moderately high temperatures favor rapid chemical reactions under the moist conditions that exist in the soil most of the time. The high rainfall increases downward leaching of soluble and colloidal materials in the soil. The soil is frozen for only short periods and to only shallow depths during winter, which further intensifies weathering and the translocation of materials.

The general climate of the valley area is relatively uniform, but small local differences in soil temperature exist because of variations in the slope and exposure of land. On slopes facing south and west the average daily and annual temperature of the soil is somewhat higher than on those facing north and east. Soil temperatures are also higher on the steeper slopes. Average moisture content of the soils is less on the south and west slopes than on those of the north and east (13).

The different conditions of soil moisture and temperature affect the length of time that the soil is frozen and the growth of vegetation. Although the differences are small, they are significant, and are possibly responsible for some of the local variations in soils derived from similar parent materials. Over the entire valley area, however, the differences in climate are not of sufficient magnitude to account for broad differences that exist among the soils. The relatively uniform climate of the area as a whole is apparently responsible for some of the outstanding common properties of many of the soils, but because of its relative uniformity, climate cannot account for the broad differences that exist.

Trees, shrubs, grasses and other herbaceous plants, micro-organisms, earthworms, and other forms of plant and animal life live on and in the soil, and they are active agencies in the soil-forming processes. The nature of the changes that these various biological forces bring about depends, among other things, on the kinds of life and the life processes peculiar to each. The kinds of plants and animals are determined by environmental factors, including climate, parent material, relief, age of the soil, and the associated organisms. The influence

of climate is most apparent, though not always the most important, in determining the kinds of macroflora that grow on the well-drained, well-developed soils. In this way climate exerts a powerful indirect influence on the morphology of soils. Climate and vegetation acting together are the active factors of soil genesis.

A general oak-hickory-chestnut forest association was on most of the well-drained, well-developed soils, though locally there may have been large proportions of pine in the forest stands (see section on Forests). There were probably differences in the density of stands, the relative proportion of species, and the associated ground cover. Taking the area as a whole, however, the forests appear to have been relatively uniform, and it is doubtful that any of the marked differences in properties among the well-drained, well-developed soils are the direct result of differences in vegetative cover.

Most of the trees that grow in this area are moderately deep to deep feeders on plant nutrients. They are chiefly deciduous trees and shed their leaves annually. The leaves differ considerably among species in content of various plant nutrients, but in general the quantity of bases and phosphorus returned to the soil in leaves of deciduous trees is high as compared with that returned by leaves of coniferous trees. The trees therefore bring essential plant nutrients from the lower part of the soil to the upper and in this way retard the depleting action of percolating waters.

Much organic material is added to the soil in the form of dead leaves, roots, and entire plants. Most of it is added to the A horizon, where it is acted upon by micro-organisms, earthworms, and other forms of life and by direct chemical reactions. Little is known of the micro-organisms, earthworms, and other population of the soils of the area, but their importance is probably equal to that of the vegetation. In the Norris area, organic matter decomposes rather rapidly because temperature and moisture conditions, the character of the organic material itself, and presumably, the micropopulation of the soil, are all favorable. Organic material does not accumulate on well-drained sites in this area to the extent that it does in cooler regions having similar drainage conditions.

The well-drained, well-developed soils have been formed under relatively similar conditions of climate and vegetation. It is on these soils that climate and vegetation have had the maximum influence. As a result, the soils developed from various kinds of parent materials have many properties that are common to all.

In virgin conditions all of the well-drained, well-developed soils have a surface layer of organic debris in varying stages of decomposition. All have a dark-colored A₁ horizon. The A₂ horizon is lighter in color than either the A₁ or the B. The B horizon is generally a uniform yellow, brown, or red and is heavier textured than the A₁ or A₂. The C horizon is variable in color and texture among the different soils, but is usually light red or yellow, mottled with gray or brown.

Analyses of samples of several comparable soils from Jefferson County, Tenn., may be expected to apply to these soils (15). The silica content decreases and the alumina and iron contents increase with depth. The content of organic matter is moderate in the A horizon, less in the A₂, and very low in the B and C. The soils are low in

bases and phosphorous within the solum and strongly or very strongly acid throughout. Since the loss on ignition is generally low, a low content of very tightly held water is indicated. In general the quantities of silt decrease and the quantities of clay and colloid increase with depth from the A₁ through the C horizon. The colloid content of the B horizon is much higher than that of the A₂.

The properties just mentioned are common to all well-developed, well-drained soils that have been subjected to similar conditions of climate and vegetation. They are therefore common to soils of zonal extent, and all soils that exhibit them can be called zonal. Zonal soils are members of one of the classes of the highest category in soil classification, and they are defined as soils having well-developed soil characteristics that reflect the influence of the active factors of soil genesis—climate and living organisms (18).

Where the parent materials have been in place a long time and have not been subject to extreme conditions of relief or where the parent materials themselves do not possess extreme characteristics, the soils developed have the properties of zonal soils. Where the parent material has been in place only a short time, as in the case of that recently transported, the soils have poorly defined or no genetic horizons. These soils are young, have few or none of the properties of zonal soils, and are therefore called azonal. Azonal soils are members of a second class of the highest category of soil classification and are defined as a group of soils without well-developed soil characteristics either because of their youth or because of conditions of parent material or relief that have prevented the development of definite soil characteristics (18).

These azonal soils are characterized by a moderately dark to very dark A₁ horizon and apparently moderately to fairly high organic-matter content; by the absence of a zone of illuviation, or B horizon; and by parent material usually lighter in color than the A₁ horizon but that may be similar to, lighter than, or heavier than the A₁ horizon in texture. They may be referred to as A-C soils because of the absence of a B horizon.

On some steep areas where a relatively small quantity of water percolates through the soil and where the large volume and the accelerated rate of runoff contribute to relatively rapid geologic erosion, the soils are young. The materials are constantly renewed or mixed, and the changes brought about by vegetation and climate may be so slight that the soils have essentially A-C horizons. These are also azonal soils.

On some nearly level areas where both internal and external drainage are restricted or where geologic erosion is very slow, the materials have been in place a long time, and the soils formed have certain well-developed profile characteristics that zonal soils do not have. Such soils are associated geographically with the zonal soils and are called intrazonal. They are defined as soils having more or less well-developed soil characteristics that reflect the dominating influence of some local factor of relief or parent material over the normal effects of climate and vegetation (18). The properties of the intrazonal soils in this area are generally the result of level relief influenced greatly by the character of the parent material and the kinds of vegetation.

Soils of each of the three broad classes—zonal, azonal, and intrazonal—may be derived from similar kinds of parent materials. In this area major differences among soils within any one of the three classes are apparently closely related to differences in the kinds of parent materials. The resistance of the rock to weathering, the volume of residue after weathering, and the rate of geologic erosion determine the thickness of soil over the parent rock; and the chemical and physical nature of the parent material modifies the rate and direction of chemical changes that result from climate and vegetation. The kind of parent material also exerts a pronounced influence on the kinds of vegetation that grow on the soil.

Rock formations have contributed to differences among soils through their effects on relief. The rock formations over most of the Norris area are very old and folded and faulted (19, 20).²⁰ The present relief probably results largely from geologic weathering and erosion of these formations; the higher lands are capped by the more resistant and the valleys are underlain by the less resistant formations (8). The ridges of Norris area are capped by cherty dolomite, interbedded sandstone and shale, acid shale, sandstone, or conglomerate; and the valleys are underlain by moderately pure limestone, interbedded shale and limestone, or by soft shale.

The properties of soils developed from residual materials are closely related to the underlying rock formations and the distribution of soils is therefore related to the valleys and ridges. Dewey, Talbott, and Colbert soils are chiefly in rolling upland valleys; Clarksville, Fullerton, Claiborne, Bolton, Montevallo, Armuchee, and Lehew soils on valley ridges; and Muskingum soils on the high valley mountains. Streams in the ridges and mountains generally have steeper gradients than those in the valleys, and, as a result of faster stream cutting and greater relief from the stream floors to the dividing ridge crests, most of the soils of the ridges and mountains have steeper slopes than those of the valleys. Through their influence on relief, the rock formations have contributed indirectly to the properties of some soils.

The internal drainage of soils of nearly level relief in the limestone areas is exceptionally good as a result of subterranean drainage through caverns and crevices in the sharply dipping rocks. This excellent drainage counteracts the usual effects of gentle relief and allows the nature of the parent rock to dominate in determining local differences among the well-developed, well-drained soils derived from residual materials and subject to similar forces of climate and vegetation.

CLASSIFICATION OF SOIL SERIES

The genetic relations of the soils of the area are more easily understood after referring to table 7, in which the soil series are classified according to orders (zonal, intrazonal, and azonal soils) and great soil groups. The sources and kinds of parent material, outstanding profile characteristics, and other major properties are also given in the table for each of the series.

²⁰ See footnote 6, p. 6.

TABLE 7.—Classification of the soil series of the Norris area, Tennessee, in higher categories

ZONAL SOILS

Great soil group and series	Parent material	Topographic position	Dominant relief	A Horizon	B Horizon
Red Podzolic soils: Talbot.....	Residuum from— Argillaceous limestone.....	Limestone valley uplands.....	Undulating and rolling	Grayish-brown silt loam or silty clay loam. Brown silt loam.....	Yellowish-red silty clay; sticky and plastic. Brownish-red silty clay.
Dewey.....	High-grade or slightly cherty limestone.	do.....	do.....		
Bolton.....	Cherty and arenaceous dolomite and dolomitic limestone.	High cherty ridges.....	Rolling to steep.....	Dark-brown silt loam; mellow and friable.	Dark-red silty clay loam; friable and mellow.
Claiborne.....	do.....	do.....	Hilly and steep.....	Grayish-brown to brown friable silt loam.	Yellowish-brown moderately friable silty clay loam.
Fullerton.....	do.....	do.....	Rolling and hilly.....	Brownish-gray cherty silt loam.	Yellowish-red or light-red cherty silty clay loam.
Allen.....	Old local alluvium chiefly from— Sandstone with some limestone influence.	Old colluvial fans and benches.	Sloping.....	Grayish-brown to brown loam..	Reddish-brown or yellowish-red fine sandy clay.
Caylor.....	Limestone, shale, and sandstone.	do.....	Nearly level to sloping.	Brown friable silt loam.....	Yellowish-brown or brownish yellow silty clay or silty clay loam.
Cumberland.....	Old stream alluvium from— Limestone.....	Old rolling stream terraces..	Gently sloping to sloping.	Brown silt loam.....	Reddish-brown silty clay.
Yellow Podzolic soils: Clarksville.....	Residuum from— Cherty and arenaceous dolomite..	High cherty ridges.....	Hilly and steep.....	Light-gray cherty silt loam.....	Brownish-yellow cherty clay loam.
Sequoia.....	Interbedded limestone and shale.	Shale valley uplands.....	Undulating and rolling.	Grayish-brown silt loam.....	Reddish-yellow silty clay loam or silty clay.
Capshaw.....	Old stream alluvium from— Limestone.....	Level to gently sloping stream terraces.	Gently sloping to sloping.	do.....	Yellowish-brown to brownish-yellow heavy silty clay loam.
Sequatchie.....	Sandstone, shale, and some limestone.	do.....	do.....	Light-brown to grayish-brown fine sandy loam.	Yellowish-brown to brownish-yellow fine sandy clay loam.
Jefferson.....	Old local alluvium from— Sandstone.....	Old colluvial fans and benches.	Gently to strongly sloping.	Brownish-gray or yellowish-gray loose fine sandy loam.	Brownish-yellow sandy clay loam.
Leadvale.....	Shale.....	do.....	Gently sloping to sloping.	Brownish-gray silt loam.....	Brownish-yellow silty clay loam.

TABLE 7.—Classification of the soil series of the Norris area, Tennessee, in higher categories—Continued

INTRAZONAL SOILS

Great soil group and series	Parent material	Topographic position	Dominant relief	A Horizon	B Horizon
Planosols: Tyler.....	Old stream alluvium from— Sandstone and shale.....	Nearly level to slightly depressional.	Level.....	Light-gray slightly mottled silt loam.	Gray highly mottled silty clay.

AZONAL SOILS

Lithosols: Colbert.....	Residuum from— Argillaceous limestone.....	Limestone valley uplands.....	Undulating and rolling. Hilly and steep.....	Shallow soil; dark-gray silty clay loam over brownish-yellow sticky plastic silty clay; bedrock at 24 inches.
Armuchee.....	Interbedded shale and limestone.	Steep-sloped knobs and ridges.	do.....	Shallow soil; grayish-brown silt loam underlain by brownish-red silty clay mixed with shale; bedrock at about 24 inches.
Montevallo.....	Acid fissile shale.....	do.....	do.....	Shallow soil; brownish-gray silt loam mixed with shale bedrock at 12 to 24 inches.
Lehew.....	Interbedded sandstone and shale.	do.....	Steep and very steep.....	Shallow soil; purplish-brown fine sandy loam mixed with shale and sandstone fragments; bedrock at 12 to 30 inches.
Muskingum.....	Massive sandstone and conglomerate.	Mountain slopes.....	Hilly and steep.....	Shallow soil; brownish-gray fine sandy loam underlain by brownish-yellow sandy clay loam; bedrock at about 24 inches.
Hector.....	do.....	do.....	Steep.....	Shallow soil; grayish-brown loose fine sandy loam underlain by reddish-brown friable fine sandy clay loam; bedrock at about 24 inches.
Alluvial soils: Roane.....	Recent stream alluvium from— Cherty dolomite.....	Stream-bottom lands.....	Nearly level.....	Grayish-brown well-drained silt loam; cemented layer at about 10 to 24 inches.
Lindside.....	Dolomite and high-grade limestone.	do.....	do.....	Brown silt loam underlain by mottled gray silt loam to silty clay loam; imperfectly drained.
Pope.....	Chiefly acid sandstone, with some acid shale influence.	do.....	do.....	Well-drained grayish-brown fine sandy loam.
Philo.....	do.....	do.....	do.....	Brownish-gray fine sandy loam underlain by gray mottled fine sandy loam; imperfectly drained.
Emory.....	Recent local alluvium from— Dewey, Claiborne, and Bolton soils.	Young colluvial fans and benches.	Nearly level to gently sloping.	Brown well-drained deep friable heavy silt loam.
Greendale.....	Clarksville and Fullerton soils.	do.....	Nearly level to sloping.	Grayish-brown silt loam underlain by brownish-yellow silt loam or light silty clay loams; cherty; well drained.
Ooltawah.....	Talbott, Dewey, Fullerton, and Clarksville soils.	do.....	Nearly level, depressional.	Grayish-brown silt loam underlain by mottled gray silt loam or silty clay loam; imperfectly drained.

In the following pages the morphology and genesis of the various soil series are discussed by great soil groups.

RED PODZOLIC SOILS

The Red Podzolic great soil group is a zonal group of soils having thin organic and organic-mineral layers over a yellowish-brown leached layer that rests on an alluvial red horizon; it developed under deciduous or mixed forest in a warm-temperate moist climate (12). The soil-forming processes involved in the development are laterization and podzolization. The soils of this group in the Norris area have the common characteristics of Red Podzolic soils, and apparently all have developed under relatively similar conditions of climate and vegetation. They are well drained, and although they range somewhat in degree of maturity, all are sufficiently old to have at least a moderately well-developed Red Podzolic soil profile. They range from level to steep. Differences among the soil profiles are not due primarily to slope, but they can be correlated with differences among parent materials.

TALBOTT SERIES

Soils of the Talbott series have heavy-textured B and C horizons and are relatively shallow over bedrock. Their texture is related to the argillaceous limestone from which the parent materials are derived. The limestone leaves a relatively small amount of insoluble residue after weathering. The soils erode readily when cultivated, and their probable relatively rapid erosion under natural vegetation may account in part for their shallow depth over bedrock. Like the other zonal soils of the area, they have developed under a deciduous forest vegetation in a warm-temperate moist climate. The soils are medium to strongly acid throughout.

Following is a description of a representative virgin profile of Talbott silty clay loam, eroded hilly phase:

- A₁. 0 to 2 inches, grayish-brown friable silt loam with a fine crumb structure; low to medium in organic matter.
- A₂. 2 to 8 inches, grayish-brown to yellowish-brown moderately friable heavy silty clay loam with a fine crumb structure; contains some gray mingles and siftings of material from the A₁ layer and becomes somewhat sticky and plastic when wet; relatively low in organic matter.
- B₂. 8 to 26 inches, compact tough plastic sticky yellowish-red silty clay with an angular nut structure; surface of the structure particles is coated with red, yellow, brown, and olive; material very hard and intractable when dry; contains small firm black concretions and a few angular chert fragments.
- B₃. 26 to 36 inches, yellowish-red heavy silty clay mottled with shades of red, yellow, and brown, and having an angular nut structure; less compact in place than the B₂ layer, and the aggregates are more easily crushed into a coarse crumbly mass.
- C. 36 to 60 inches, heavy bright-red plastic clay heavily mottled with yellow, gray, olive, and shades of brown; breaks into coarse, irregularly shaped aggregates when disrupted and contains some angular chert fragments; consolidated, slightly argillaceous, slightly cherty limestone under this layer.

Most of the soil is cleared and cultivated; the A₁ and A₂ layers have been mixed by tillage, and in many places most or all of the surface layer is now missing because of removal by accelerated erosion.

DEWEY SERIES

Soils of the Dewey series are developed from residuum of limestone higher in some insoluble materials, particularly silica, than the rock underlying soils of the Talbott series. The soils are generally thicker over bedrock and darker red throughout the profile than the Talbott soils. There is generally more organic matter in the upper soil layers than in the corresponding layers of the Talbott soils, and textures are usually lighter throughout the profile. Soils of this series have somewhat stronger relief in many places than do the Talbott soils; but the vegetation, especially the ground cover, although developed under similar climate, is slightly more dense. It is probable that the major differences between the soils of the two series are directly or indirectly the results of the differences between the parent materials.

Following is a description of a virgin profile of Dewey silt loam, undulating phase:

- A₁. 0 to 3 inches, brown friable silt loam with a fine crumb structure, moderately high in organic matter and matted with tree rootlets.
- A₂. 3 to 12 inches, brown to dark grayish-brown friable silt loam with a crumb structure; contains a few fine chert fragments and is moderately well supplied with organic matter; small tree rootlets are numerous.
- A₃. 12 to 16 inches, yellowish-brown friable light silty clay loam with a fine crumb structure; contains some fine chert fragments and a few small dark-brown concretions.
- B₂. 16 to 32 inches, brownish-red slightly plastic heavy silty clay loam with a subangular nut structure, the particles of which crush to a yellowish-red fine crumbly mass; layer contains many small dark-brown concretions and some fine chert fragments.
- B₃. 32 to 44 inches, red or yellowish-red silty clay, sticky when wet and hard and brittle when dry; has a firm nut structure, the faces of the structure particles being covered with thin, deep-red coatings; layer contains small chert fragments and many small dark-brown concretions.
- C. 44 to 80 inches, yellowish-red silty clay with mottlings of gray, yellow, brown, ocher, and olive; very sticky when wet; has a fairly distinct subangular nut structure and contains many small weathered chert fragments.

Most of the soil is now cleared and the A₁ and the A₂ horizons are mixed. In places most of these layers may have been removed by accelerated erosion and the A₃ horizon is now at or near the surface.

BOLTON SERIES

Like the Claiborne soils, those of the Bolton series are on or near the crests of high and steep ridges underlain chiefly by cherty and arenaceous dolomite and are in close geographical association with the Fullerton soils. In general type of relief, age, parent material, climate, and vegetation the Bolton, Claiborne, and Fullerton soils are similar, but there are local variations in one or more of these factors. The Bolton soils differ from the Fullerton in being darker colored in all layers, higher in organic matter, more fertile, less acid, much less cherty, more friable, especially in the B and C horizons, and deeper. They differ from the Dewey soils in being more friable in the B and C horizons, much less erosive, and much deeper over bedrock, and in being on or near the crests of some of the highest cherty ridges of the area rather than in low-lying upland valleys. In general the Bolton soils are the darkest colored, least erosive, and most friable of all of the Red Podzolic soils developed from either limestone or dolomite.

No completely satisfactory explanation of the differences between these soils and those of the Fullerton series can be given, but it appears that local differences in soil climate and parent materials are largely responsible. As with the Claiborne, the Bolton soils are chiefly on slopes facing north and east where the soil is cooler and moister, and the plant growth is more vigorous. As a result the soil is less leached, less acid, and contains more organic matter and more plant nutrients. Geologic erosion appears to be less rapid and a thicker solum is developed.

Much of the Bolton soils is developed on thin layers or lenses of nearly chert free slightly arenaceous dolomite, and it is therefore chert free and friable. The abundant small brown concretions in the B horizon are apparently partly oxides of manganese, and it is possible that small quantities of these oxides account in part for the dark reddish-brown color. There are undoubtedly many unknown factors that contribute to the differences that exist between Bolton soils and those of the Fullerton and Claiborne series.

The following describes a virgin profile of Bolton silt loam, hilly phase:

- A₁. 0 to 2 inches, dark-brown soft mellow silt loam that is high in organic matter.
- A₂. 2 to 12 inches, dark-brown to reddish-brown soft mellow silt loam with a fine crumb structure and a distinctive soft friable consistence; moderately high in humus and contains many small tree rootlets.
- A₃. 12 to 18 inches, yellowish-brown or light-brown friable heavy silt loam with a fine crumb structure; firmer in consistence and heavier in texture than the A₁ and A₂ layers.
- B₁. 18 to 24 inches, light-red silty clay loam; contains flecks and siftings of brown and yellow material from the layers above, and crushes to a soft smooth yellowish-brown mass; contains a few fine chert fragments and some small dark-brown concretions.
- B₂. 24 to 48 inches, dark-red to brownish-red moderately friable silty clay loam easily crushed to a soft smooth brown mass when moist but somewhat sticky when wet; has a weakly developed fine subangular nut structure; layer contains some dark-brown concretions and a few fine weathered chert fragments.
- B₃. 48 to 60 inches, red silty clay similar to that of the B₂ layer but slightly heavier in texture, lighter in color, and higher in content of chert fragments.
- C. 60 to 90 inches, red silty clay, moderately friable when moist; crushes to a smooth red mass but is moderately sticky and plastic when wet; contains light mottlings of yellow and gray; material has a distinct fine nut structure and contains fine chert fragments and a few large angular pieces of chert; dolomite bedrock is at depths of 30 to 50 feet.

Much of the soil is cleared, and the A₁ layer is mixed with the upper part of the A₂. In places a part of the A₂ layer is missing because of erosion, but the A₃ layer is in very few places exposed at the surface or turned by tillage operations.

CLAIBORNE SERIES

The soils of the Claiborne series are chiefly on the crests and upper slopes of high steep ridges underlain by cherty or sandy dolomite of the Knox formation. They are closely associated with the Fullerton soils geographically, and in general the parent material, climate, and vegetation of the two series are similar. The factors responsible for the differences between the two are not known, but partial explanations are presented here.

Local differences in soil temperature offer one explanation. Much of the Claiborne soil is on slopes facing north or northeast. It is definitely known that soil temperature is lower and soil moisture is higher on such sites (13). This lower temperature results in longer and more severe freezing of the soil in winter, which would prevent leaching and inhibit bacterial activity. The more favorable moisture and temperature conditions result in a slightly different kind and a more vigorous growth of vegetation. In most places maple, beech, and yellow-poplar are the dominant trees, and in general, they return a greater amount of organic matter higher in bases and phosphorus than do the oak and hickory that prevail on most Fullerton soils. Thus, a more favorable soil climate encourages more vigorous vegetative growth, which results in a less leached, darker colored soil with a higher content of organic matter, bases, and plant nutrients.

Local differences in parent material may be partly responsible for development of this soil, inasmuch as it is closely associated with some of the sandy layers in the dolomite in many places. Neither of these explanations is entirely satisfactory, however, because in some places the soil is not associated with the factors discussed. These factors, however, together with some that are now unknown, are responsible for the morphology of Claiborne soil.

The profile of Claiborne silt loam, rolling phase, described below, was developed under a forest of maple, beech, yellow-poplar, chestnut, oak, and dogwood:

- A₁. 0 to 3 inches, dark grayish-brown mellow friable silt loam high in organic matter and heavily matted with tree rootlets.
- A₂. 3 to 12 inches, grayish-brown to brown mellow friable silt loam with a fine crumb structure; layer is fairly well supplied with organic matter; contains a few small chert fragments, and tree rootlets are plentiful.
- A₃. 12 to 16 inches, yellowish-brown light silty clay loam, having a firmer consistence and a smaller content of organic matter than the A₂ layer.
- B₂. 16 to 32 inches, yellowish-brown silty clay loam, moderately friable when moist and moderately sticky when wet; has a distinct but weak nut structure and crushes to a smooth dark brownish-yellow mass; contains a few chert fragments and small dark-brown concretions.
- B₃. 32 to 46 inches, yellowish-red or reddish-yellow silty clay loam with a firm well-developed nut structure, the structure particles having red and yellow glossy coatings; material heavier in texture and more sticky and plastic than that of the B₂ layer and contains many angular chert fragments.
- C. 46 to 60 inches, red or yellowish-red heavy silty clay somewhat compact in places; material moderately friable when moist, and sticky and plastic when wet; has a well-developed firm nut structure, the structure particles being coated with red, yellow, ocher, and olive and the soil material mottled with these colors; a large quantity of angular chert fragments, 1 to 6 inches in diameter, are in this layer; dolomite bedrock is at depths of 20 to 50 feet.

As with other upland soils, the A₁ and A₂ horizons are mixed where the soil is cleared, and in most places a part of the mixed layer is missing because of the loss through accelerated erosion. In general Claiborne soils have a greater moisture-holding capacity and are therefore less susceptible to erosion than the Fullerton soils.

FULLERTON SERIES

Soils of the Fullerton series are developed chiefly from the residue of dolomite, but to a lesser extent from residue of dolomitic limestone high in insoluble materials, mainly silica. The silica is generally in

the form of chert, but locally, calcareous sandstone beds in the dolomite have contributed to the parent material of these soils. Fullerton soils commonly occupy higher positions and are deeper, less fertile, and less erosive, more cherty, and steeper in slope than the Dewey and Talbott soils. The parent materials of the Fullerton soils differ from those of the Talbott and Dewey in two important respects: (1) They are derived from and underlain by dolomite rather than limestone, and under ordinary atmospheric and aqueous conditions, dolomite alters like limestone but less readily (5); and (2) they contain more insoluble materials, principally silica.

It is generally true that the quantities of insoluble materials in the parent rock increase from the Talbott through the Dewey to the Fullerton soils. Associated with this increase is generally an increase in the chertiness, thickness, and permeability, and a decrease in the content of plant nutrients, cohesive properties, and susceptibility to erosion. The lower susceptibility to erosion and the greater volume of residue from weathering of the rocks apparently results in a thicker mantle of unconsolidated rock material over bedrock under the Fullerton soils than under Talbott or Dewey soils. This mantle probably protects the bedrock from rapid weathering, and together with the fact that dolomite weathers more slowly than limestone, may largely account for the higher position and the resultant steeper slopes of the Fullerton soils.

The profile of Fullerton silt loam, rolling phase, described below, was developed under a mixed forest of red, white, and black oaks, chestnut, hickory, and blackgum, with huckleberry, chinquapin, and dogwood prominent in the undergrowth:

- A₁. 0 to 2 inches, gray loose silt loam stained with organic matter and heavily matted with tree rootlets.
- A₂. 2 to 10 inches, brownish-gray (gray when dry) friable silt loam; has a fine crumb structure and is low to medium in organic matter; small chert fragments and small tree rootlets are plentiful.
- A₃. 10 to 14 inches, yellow to grayish-yellow friable heavy silt loam; breaks into small soft rounded nutlike aggregates that easily crush to a yellow smooth mass; layer is streaked and splotched with gray siftings from the A₂ layer and contains some fine chert fragments.
- B₂. 14 to 34 inches, yellowish-red silty clay loam or silty clay with a well-developed moderately firm subangular nut structure; moderately friable when moist but sticky and plastic when wet; crushes to a fine crumbly reddish-yellow mass when dry; contains a small quantity of fine chert fragments.
- C. 34 to 60 inches, red or reddish-yellow silty clay with a well-developed nut structure; structure particles are covered with glossy coatings of yellow, brown, ocher, and gray, and the soil material is mottled with these colors; small hard black concretions are in the upper part; this layer contains angular chert fragments, the relative proportion increasing with depth; cherty dolomite bedrock is at depth of 20 to 50 feet.

Much of the soil is now cleared and cultivated. In the cultivated areas the A₁ and A₂ layers are mixed and the organic matter is largely dissipated. Part or all of this surface layer and part of the A₃ layer are missing in places because of loss through accelerated erosion, and the B₂ layer is at or near the surface.

ALLEN SERIES

The soil of the Allen series has gently sloping to sloping relief. It has developed under a deciduous forest, chiefly from colluvial and

local alluvial materials that have come mainly from uplands underlain by sandstone, conglomerate, and shale with some limestone influence. There is free movement of percolating waters, and the supply of bases is low enough to promote rapid development of the properties of a mature genetic profile. Allen loam is the only member of the series mapped in the area.

In many places Jefferson soil with an azonal or weakly developed yellow Podzolic profile has developed on what, superficially at least, appears to be parent materials similar to those of the Allen soil. The differences between the two soils can be accounted for, at least in part, by differences in parent material and age. In the Norris area all of the Allen soil is affected to some degree by calcareous materials. Practically all is underlain at considerable depth by high-grade limestone bedrock, and most of it is affected to some extent by waters that flow over or through limestone materials. In contrast, nearly all of the Jefferson soil is underlain by acid rock, and percolating waters flow only through noncalcareous materials.

As mapped in the Norris area, the Allen soil is some distance from the slopes from which the major part of the parent materials were washed. Apparently the faces of the mountain slopes are being eroded and are slowly retreating so that the colluvial benches are left some distance out in the valley. As a result the Allen soil does not receive annual increments of colluvial material.

The following describes a profile of Allen loam :

- A₁. 0 to 1 inch, dark-gray friable loam, high in organic matter.
- A₂. 1 to 9 inches, grayish-brown to brown friable loam with a fine crumb structure; relatively low in organic matter.
- B₁. 9 to 14 inches, yellowish-brown to light-brown fine sandy clay loam, friable when moist but somewhat brittle when dry; has no definite structure and is easily crushed to a soft smooth yellowish-brown mass.
- B₂. 14 to 30 inches, yellowish-red to reddish-brown slightly plastic fine sandy clay or sandy clay loam; breaks in small rounded nutlike aggregates and is moderately friable; crushes to a smooth red mass when moist but is sticky when wet; layer contains some small black concretions.
- B₃. 30 to 40 inches, red to yellowish-red light silty clay, sandy clay or sandy clay loam; breaks into a crumbly mass, and is more friable than the B₂ layer and less sticky when wet; layer may contain a few small sandstone and shale fragments.
- C. 40 to 84 inches, dominantly yellowish-red material, moderately friable when moist but somewhat sticky and plastic when wet; contains heavy mottlings of yellow, gray, olive, and green and ranges in texture from a silty clay to fine sandy clay; layer contains many fragments of partly weathered gray and red sandstone, yellow, red, and gray shale, and many quartz pebbles.

CAYLOR SERIES

The soils of the Caylor series are on colluvial fans and benches at the foot of valley-mountain slopes in limestone valleys and have nearly level to sloping relief. Their parent materials include local alluvium and colluvium washed from sandstone, calcareous shale, and limestone. They were formed under a hardwood forest in a climate similar to that under which the other mature soils of the area were developed. As mapped in the Norris area, they are closely associated geographically with the Armuchee and Talbott soils and to a lesser extent with the Allen soil.

In position and sources of parent materials the Caylor soils are somewhat similar to the Allen but differ in being browner, less leached, and therefore less acid and more fertile. The reasons for differences between the two are not entirely known, but it appears that differences in age, parent material, and possibly soil temperature are contributing factors. In general the materials from which the Caylor soils have developed contain a higher proportion of limestone and in addition probably receive some annual increments of lime from seepage waters and in runoff from the surrounding mountain slopes. These increments replenish the bases and probably cause these soils to appear less leached and younger than the Allen soil.

Inasmuch as the Norris area is in the extreme northern part of the region of Red and Yellow Podzolic soils, it is possible that local differences in site may have caused differences in soil temperature great enough to permit the formation of Gray-Brown Podzolic soils. The brownish B horizon of the Caylor soils may have been developed in this way. The Caylor soils resemble the Hayter of southwestern Virginia, but they differ from them in being somewhat older, in having more distinctly developed profiles, and being shallower over limestone residuum or bedrock. The Hayter soils are classified as Gray-Brown Podzolic soils, but in the Norris area the Caylor soils are included with the Red Podzolic soils.

The following describes a representative virgin profile of Caylor silt loam, rolling phase:

- A₁. 0 to 2 inches, dark grayish-brown friable silt loam—the dark color is apparently due to the high content of organic matter; layer is heavily matted with tree rootlets.
- A₂. 2 to 10 inches, brown to grayish-brown smooth mellow friable silt loam with a fine crumb structure; layer is apparently moderately high in organic matter and contains many small tree rootlets.
- A₃. 10 to 16 inches, brownish-yellow silty clay loam with an indistinct subangular nut structure; moderately friable when moist and crushes to a smooth brownish-yellow mass; material somewhat sticky when wet.
- B₂. 16 to 34 inches, yellowish-brown friable silty clay loam with a fine subangular nut structure; moderately firm in place but easily disrupted; structural aggregates are fairly easily crushed to a crumbly brownish-yellow mass when moist; material sticky and plastic when wet.
- C. 34 to 60 inches, brownish-yellow silty clay spotted with red, brown, and yellow; easily disrupted into angular nutlike aggregates that can be crushed to a moderately friable mass when moist; material is sticky and plastic when wet; contains some fragments of green, yellow, purple, and red shale and sandstone, small pieces of chert, and a few soft small brown concretions; layer is underlain at variable depths by limestone residuum or high-grade limestone bedrock.

Nearly all of the soil is cleared and cultivated, and the upper layers are mixed. Only in a few places is the soil so eroded that the B horizon is turned by tillage operations.

CUMBERLAND SERIES

The Cumberland series is represented in this area by only one type, Cumberland silt loam. It is a well-developed Red Podzolic soil and has formed from very old deposits of alluvium consisting mainly of residue weathered from limestone and some shale and sandstone. A heavy forest growth and a consequent high content of organic matter

in the upper layer of the soil apparently resulted from relatively high fertility and favorable moisture conditions. The Cumberland soil resembles the Dewey soils in many properties but is darker in color, thicker in solum, and deeper over bedrock.

The following describes a virgin profile of Cumberland silt loam:

- A₁. 0 to 3 inches, dark grayish-brown friable silt loam with a large quantity of organic matter.
- A₂. 3 to 12 inches, brown to dark grayish-brown friable silt loam with a fine crumb structure, slightly brittle when dry but easily crushed to a light-brown mass when moist.
- B₂. 12 to 36 inches, reddish-brown moderately plastic silty clay or heavy silty clay loam with a well-developed subangular nut structure.
- B₃. 36 to 48 inches, red plastic silty clay with a well-developed subangular nut structure; structural aggregates are covered with yellow, red, and brown coatings; material contains brown concretions.
- C. 48 to 80 inches, friable light-red to yellowish-red silty clay spotted with gray, red, and yellow; the weakly developed nut structure crushes to a soft incoherent mass when disrupted; material contains some concretions.

All the soil is cleared and cultivated, and part or most of the A horizon is missing in many places.

YELLOW PODZOLIC SOILS

Yellow Podzolic soils are a group of zonal soils having thin organic and organic-mineral layers over a grayish-yellow leached layer that rests on a yellow horizon (*I₂*). Those of the Norris area have undulating to steep relief and were developed under a forest vegetation that consisted mainly of deciduous trees with a considerable number of pines in some places. There may have been more pines and a somewhat less luxuriant and different kind of undergrowth on these soils than on the Red Podzolic soils of the area. Climate conditions on the soils of the two groups were apparently much the same. The parent materials were derived from cherty dolomite, interbedded limestone and shale, and terrace materials.

The causes of the pronounced color differences between the Yellow and the Red Podzolic soils are not known. Apparently the Yellow Podzolic soils of the area are generally associated with parent materials either lower in bases or less well drained internally than those of the Red Podzolic soils.

CLARKSVILLE SERIES

The Clarksville soils are closely associated geographically with the Fullerton soils, but are developed from materials weathered from dolomite or dolomitic limestone that is much more siliceous than the limestone from which the Fullerton soils are derived. Clarksville soils developed under a forest that was largely deciduous and are generally less subject to erosion, more cherty, and deeper over bedrock than the Fullerton. The chain of zonal soils developed from limestone and dolomite (Talbot, Dewey, Bolton, Claiborne, and Fullerton) is completed by the Clarksville soils.

The parent material of the Clarksville soils possibly has many of the same effects that materials weathered from sandstone have on the soils that develop from that source. The highly siliceous dolomite is weathered to a great depth, and the residue is strongly acid and has a low base exchange capacity, indicating that the siliceous part domi-

nates the parent material. The thick covering of residue protects the unweathered rock and accounts in part for the high positions Clarksville soils occupy and the resultant steepness of some of the slopes. The Clarksville soils are not so susceptible to erosion as are other soils developed from dolomite residuum in the area, a condition that may be partly responsible for the thickness of weathered material over bedrock.

The profile of Clarksville cherty silt loam, rolling phase, described below was developed under a forest of chestnut, post and black oaks, hickory, blackgum, sourwood, red maple and chestnut, with huckleberry, dogwood, serviceberry, and blackhaw in the undergrowth.

- A₁. 0 to 1 inch, light-gray loose silt loam stained with organic matter and heavily matted with tree rootlets.
- A₂. 1 to 10 inches, pale yellowish-gray to light-gray loose friable silt loam almost white when dry; material is low in humus and contains many angular chert fragments 1 to 3 inches in size.
- B₂. 10 to 26 inches, brownish-yellow light clay loam with no distinct structure, slightly brittle but easily shattered to a loose powdery yellow mass that contains a large quantity of angular chert fragments and some small black concretions; in places the lower part of this layer may be brownish-yellow and have a weakly developed nut structure.
- C. 26 to 40 inches, brownish-yellow gritty clay loam, which may have a weakly developed subangular nut structure but is easily crushed to a soft crumby yellow mass; material is heavily mottled with gray, ocher, olive, and light red and in places contains many soft black concretions; half or more of the material by volume is angular chert fragments; red coloration increases and the texture becomes heavier with increasing depth; bedrock of cherty dolomite is at depths of 30 to 100 feet.

Where the soil is cleared, especially on the steeper slopes, nearly all the fine soil material of the A horizon is missing because of loss through accelerated erosion.

SEQUOIA SERIES

The soils of the Sequoia series have developed under a mixed forest of hardwood and pine from parent material weathered from interbedded limestone and shale. They have undulating to rolling slopes and are well-drained externally, but internal drainage may be somewhat slow because of the shallow depth to bedrock and the heavy texture of the lower layers. These soils are geographically associated with the Armuchee soils.

The parent materials of the Sequoia soils are very similar to those of the Armuchee; the chief differences are due to relief. The Armuchee are on steep and hilly relief, and geologic erosion proceeds at a rate so rapid that a distinct soil profile cannot form; whereas the Sequoia are on relatively gentle relief, and normal soil-forming processes produce a soil with zonal characteristics.

In some respects the Sequoia soils are similar to those of the Talbott series, the chief differences in the development probably being due to the difference in lime content of the parent materials. It is likely that the more acid parent material of the Sequoia is responsible for the development of a Yellow Podzolic profile rather than a Red Podzolic one similar to that of the Talbott soils. Locally, however, small areas of Red Podzolic soil much like the Talbott soils are included with the Sequoia soils of the area, and in other places the

inclusion has a reddish-yellow color intermediate between that of a typical Red Podzolic soil and a Yellow one.

Following is a profile description of virgin Sequoia silt loam, undulating phase:

- A₁. 0 to 1 inch, dark brownish-gray loose silt loam with a relatively large quantity of organic matter; strongly acid.
- A₂. 1 to 9 inches, brownish-gray to grayish-brown friable silt loam with a fine crumb structure; low to medium in organic matter.
- B₁. 9 to 14 inches, yellow silty clay loam with a well-developed nut structure; crushes to a yellow crumbly mass when moist but is somewhat sticky when wet; strongly to very strongly acid.
- B₂. 14 to 22 inches, light reddish-yellow tough somewhat compact heavy silty clay loam or silty clay; breaks into large lumps when disrupted, but these are easily shattered into firm nutlike aggregates; sticky and plastic when wet.
- B₃. 22 to 28 inches, reddish-yellow plastic silty clay; breaks into a well-developed medium nut structure when disrupted.
- C. 28 to 40 inches, yellow to light-brownish-yellow silty clay mottled with red, light-yellow, and gray; has a well-developed firm nut structure; material is sticky and plastic when wet but moderately brittle when dry and contains some soft brown concretions in places; layer rests on partly disintegrated yellow shale interbedded with layers of blue or gray limestone.

Practically all the soils are cleared. The upper layers are mixed and in many places have been largely removed by accelerated erosion so that the upper part of the B horizon is at or near the surface.

CAPSHAW SERIES

The Capshaw series is represented in this area by one type, Capshaw silt loam. This soil is moderately well-developed from moderately old alluvium washed mainly from soils underlain by limestone. It has relatively open substrata that favor rapid leaching, but its comparatively high fertility and favorable moisture conditions appear to have caused a heavy forest growth and the resultant higher content of organic matter in the upper soil layer. In many properties, especially color, the Capshaw soil resembles the Caylor soils.

Following is a description of a virgin profile of Capshaw silt loam:

- A₁. 0 to 2 inches, dark grayish-brown mellow silt loam high in organic matter.
- A₂. 2 to 12 inches, grayish-brown to light-brown mellow silt loam with a fine crumb structure; medium high in organic matter.
- B₁. 12 to 18 inches, yellowish-brown heavy silt loam or light silty clay loam, moderately friable when moist but somewhat sticky when wet, with no well-defined structure; easily crushed to a smooth soft yellowish-brown mass when disrupted.
- B₂. 18 to 36 inches, yellowish-brown to brownish-yellow silty clay loam; breaks into small subangular nutlike particles when moist and is sticky and plastic when wet; many small dark-brown concretions and a few pieces of chert and gravel are in this layer, which is faintly mottled with yellow and gray in the lower part.
- C. 36 to 60 inches, brownish-yellow clay loam with mottlings of yellow and gray and pieces of fine chert and gravel; sticky when wet and moderately brittle when dry.

Most of this soil is now rather severely eroded, and much of the A horizon is missing.

SEQUATCHIE SERIES

The soils of the Sequatchie series (Sequatchie fine sandy loam) is on low terrace lands or second bottoms along the larger creeks and rivers and has nearly level to gently sloping relief. It has developed from

parent materials similar to those of the Pope series with which it is generally closely associated. The soil was under a hardwood forest and subject to climatic conditions similar to those of the zonal soils of the area. Some of the materials from which the soil is derived were so recently deposited that only weak profile development is apparent. Following is a profile description of Sequatchie fine sandy loam:

- A₁. 0 to 2 inches, dark grayish-brown very friable fine sandy loam with a relatively large quantity of organic matter.
- A₂. 2 to 12 inches, light-brown to grayish-brown friable fine sandy loam containing a moderate quantity of organic matter.
- B₂. 12 to 30 inches, yellowish-brown to brownish-yellow friable fine sandy clay loam; usually breaks into an incoherent granular mass but in places has an indistinctly developed weak nut structure; some sandstone fragments are in the lower part.
- C. 30 to 48 inches, light-brown to light reddish-brown fine sandy loam containing some sandstone gravel and cobbles; underlying sandy alluvium is dominantly yellow or light brown with beds of gravel and cobbles, is many feet thick, and is underlain in most places by limestone or dolomite.

JEFFERSON SERIES

The soil of the Jefferson series is on foot slopes and benches at the base of mountain slopes. Its parent materials are local alluvium and colluvium washed chiefly from the Muskingum soils on the adjoining uplands, although locally some materials from Lehigh and Montevallo soils may be included. The Jefferson soil has gently to strongly sloping relief and is well drained. It was developed under mixed forests of hardwood, pine, and hemlock under a climate essentially the same as that of the zonal soils of the area. Some areas of the Jefferson soil receive frequent increments of soil material, and in these the soil is young with little profile development and would be properly classified as an alluvial soil. The materials are low in bases and easily eluviated, however, and in most places soil with a young Yellow Podzolic profile is developed. The series is represented in the area by only one soil, Jefferson stony fine sandy loam, rolling phase.

Following is a profile description of Jefferson stony fine sandy loam, rolling phase:

- A₁. 0 to 1 inch, loose gray fine sandy loam with a moderate quantity of organic matter and heavily matted with tree rootlets.
- A₂. 1 to 8 inches, brownish-gray to yellowish-gray friable fine sandy loam with a fine crumb structure and a large quantity of sandstone fragments and quartz pebbles.
- B₂. 8 to 30 inches, brownish-yellow to yellow sandy clay loam, friable when moist but slightly brittle; shatters to an incoherent yellow mass when dry; contains angular sandstone fragments and quartz pebbles.
- C. 30 to 40 inches, yellow fine sandy clay mottled with yellow, gray, and brown; rather firm in place but easily crushed to a loose mass when removed; contains a large quantity of angular sandstone fragments.

Material similar to that in the layer last described continues to a depth of several feet and is underlain in most places by sandstone bedrock.

LEADVALE SERIES

The Leadvale soils are on foot slopes, fans, and benches at the foot of steep hills. They are closely associated with the Montevallo soils

geographically, and their parent materials consist chiefly of colluvium and local alluvium from those soils, although locally Lehew and Armuchee soils may have contributed some material. The soils have gently sloping to sloping relief, but because of the silty nature of the parent materials, they are somewhat imperfectly drained. They were formed under hardwood forest and were subject to climatic conditions similar to those under which the zonal soils developed. In some places the Leadvale soils are young and have weakly developed or indistinct profiles, which receive increments of soil material at frequent intervals. In most places, however, their profiles are sufficiently developed to justify their classification as Yellow Podzolic soils.

Following is a profile description of Leadvale silt loam, undulating phase:

- A₂. 0 to 10 inches, light grayish-brown to brownish-gray friable heavy silt loam that crushes to a smooth soft grayish-yellow mass; in the virgin profile the upper inch or two is darkened by humus; the layer contains a few small fragments of sandstone and shale.
- B₂. 10 to 24 inches, brownish-yellow to yellow moderately friable silty clay loam with a weakly developed subangular nut structure; crushes to a smooth soft yellow fine granular or crumbly mass; contains some small black concretions and is faintly mottled in the lower part.
- C. 24 to 60 inches, yellow silty clay loam or silty clay that contains streaks and mottlings of bluish-gray, ocher, and brown; is somewhat brittle in place but breaks into easily crushed subangular aggregates when disrupted; mottlings increase with depth.

Material similar to that of the C layer extends to a depth of several feet in most places and is underlain by shale bedrock or interbedded shale and limestone.

Variations from this profile will be found that are due to differences in sources of parent material, age, recency of deposition of materials, and, on the stronger slopes, to accelerated erosion.

PLANOSOLS

Planosols are an intrazonal group of soils with eluviated surface horizons underlain by B horizons more strongly illuviated, cemented, or compacted than in associated normal soils; they developed on nearly flat upland surface under grass or forest vegetation in a humid or sub-humid climate (12).

In the Norris area only the soil of the Tyler series has been designated as a Planosol. The soil is nearly level or slightly depressional and is poorly drained. The B horizon is more dense or compacted than that of most zonal soils, but the degree of development varies.

Climatic conditions are similar to those under which the zonal soils developed, but the Planosol is usually more moist and less well-aerated than are zonal soils. Some differences probably existed between the kinds of vegetation on the Planosol and Red or Yellow Podzolic soils, although deciduous forest was on both. From the standpoint of profile development the Planosol appears to be older than the Red or Yellow Podzolic soils, but the causes for development of older soils are not known. The relief is such that geologic erosion would be slow, but that factor alone is not the cause for the formation of the soil. The soil material itself is not older in years than that of associated zonal soils of similar relief. It is possible that relatively dense layers in the parent material and underlying rock strata caused slow internal

drainage, which, combined with slow external drainage and unusual siltiness of the parent material, resulted in abnormal concentration or cementation in or below the illuvial horizon.

TYLER SERIES

Soil of the Tyler series (Tyler silt loam) is on nearly level or slightly depressed parts of low terraces underlain by sandstone and shale materials. It is poorly drained both internally and externally because of level slopes, the silty character of the soil material, and the impervious nature of the underlying rock.

Following is a profile description of Tyler silt loam:

- A₁. 0 to 2 inches, gray silt loam stained with organic matter and containing many rootlets and fragments of partly decomposed plant remains.
- A₂. 2 to 6 inches, light-gray floury silt loam.
- A₃. 6 to 14 inches, yellowish-gray silt loam mottled with brown, yellow, and red, and containing soft brown concretions; mottlings and concretions are in old root channels, and old partly decayed roots are numerous.
- X. 14 to 28 inches, heavy compact gray silty clay containing mottlings of yellow and brown and breaking into large firm lumps when disrupted; root casts and concretions persist in this layer; underlying alluvium is heavy gray material, largely washed from and in most places underlain at shallow depths by acid shale.

Most of the soil is now cleared, and the upper layers have been mixed.

LITHOSOLS

Lithosols are an azonal group of soils having no clearly expressed soil morphology and consisting of a freshly and imperfectly weathered mass of rock fragments; largely confined to steeply sloping land (12). These soils occupy positions where geologic erosion is comparatively rapid and generally consist of materials relatively easily eroded. As a result, material is removed from the surface or mixed to such an extent that soil-forming processes have not acted on the soil for a sufficient length of time to produce well-defined genetic soil properties. As mapped these soils may include small areas of zonal soils.

COLBERT SERIES

The soils of the Colbert series have formed over residuum derived from the weathering of agillaceous limestone and under a mixed forest of hardwood and redcedar. They have undulating to rolling slopes. The general climate is essentially the same as that under which other soils derived from limestone materials were developed, but internally the soil is probably somewhat different because of the heavy character of the soil material, which impedes movement of soil, air, and moisture.

The Colbert soils are shallow over bedrock and have weakly developed or indistinct profiles. The lack of profile development in the other Lithosols is due chiefly to their strong slopes, whereas in this soil it is due to the resistance of the parent materials to weathering and soil-forming processes. These parent materials are very heavy tenacious clays that prevent the normal circulation of soil moisture and air and probably impede the activities of soil micro-organisms. Leaching, translocation of soil materials, oxidation, and other chemical reactions do not proceed as in a normal soil; hence, no true soil

profile is developed. In some places in the Tennessee Valley, soils classified in the Colbert series have weakly developed Yellow Podzolic profiles, but as mapped in the Norris area, they are true A-C soils and are properly classified as Lithosols.

Following is a profile description of Colbert silty clay loam, eroded rolling phase:

- A₁. 0 to 1 inch, nearly black moderately friable silty clay loam with a fine crumb structure.
- A₂. 1 to 6 inches, dark-gray to yellowish-gray silty clay loam; sticky and plastic when wet and dries to a coarse crumbly mass; aggregates are very firm, angular, and crush to a gray powdery mass.
- C. 6 to 24 inches, heavy sticky plastic tenacious compact brownish-yellow to brownish-yellow silty clay with a greenish cast in places; very hard and intractable when dry and has a well-developed nut structure; structure particles are covered with gray coatings of material that have sifted and filtered from the A₁ and A₂ layers; wedges of this gray material are in the cracks between the structural particles in some places.
- D. 24 inches +, consolidated bedrock, folded argillaceous limestone, massive in most places but containing some thin beds of acid shale.

ARMUCHEE SERIES

The Armuchee soils have formed under a hardwood forest from residuum weathered from interbedded shale and limestone. The soils have hilly and steep slopes and were formed under a climate similar to that of the zonal soils of the area, although they were probably somewhat different internally because of the steeper slopes and the greater loss of moisture through runoff. For the same reason soil temperature may have been slightly different.

The Armuchee soils are shallow and do not have well-developed profiles. Their parent materials are very similar to those of the Yellow Podzolic Sequoia soils, but because of the steep slopes and the erosive nature of the materials, they are removed by geologic erosion nearly as rapidly as formed. A normal zonal soil profile therefore cannot develop, and consequently the Armuchee are essentially A-C soils.

Following is a profile description of Armuchee silt loam:

- A₁. 0 to 2 inches, dark grayish-brown silt loam with a fine granular structure; contains some small shale fragments and is heavily matted with rootlets.
- A₂. 2 to 12 inches, light-brown to yellowish-brown friable heavy silt loam; breaks into small soft subangular aggregates easily crushed to a smooth yellowish-brown mass; contains some small fragments of partly weathered olive-colored shale.
- C. 12 to 28 inches, alternate layers of olive-colored blocky shale and brownish-red silty clay soil material that is mottled somewhat with yellow and brown and has a fairly well-developed nut structure; shale is soft and easily broken, and surfaces along the parting planes are coated with reddish or brownish glossy clayey material; layer rests on unaltered olive-colored blocky shale with layers of gray limestone.

Most of the soil is cleared and used for pasture; the upper layers are mixed and in many places have been partly removed by accelerated erosion.

MONTEVALLO SERIES

The soils of the Montevallo series were derived from acid fissile variegated shale under a mixed forest of pine and hardwood. They

have formed under a climate that was in general the same as that under which the zonal soils were formed, although the soil may have been somewhat different internally because of loss of moisture through runoff.

The Montevallo soils are very shallow over bedrock and do not have distinctly developed profiles. The underlying shales weather slowly, and the resulting soil material, being somewhat erosive and on steep slopes, is removed by geologic erosion nearly as rapidly as formed. All of the Montevallo soils on steep slopes are true A-C soils, but in a few places on milder slopes there are weakly developed shallow Yellow Podzolic soils that might properly be designated as Lithosolic Yellow Podzolic soils.

The following is a profile description of Montevallo shaly silt loam:

- A₁. 0 to ½ inch, loose open silt loam with a moderate quantity of fairly well incorporated organic matter.
- A₂. ½ to 6 inches, light brownish-gray loose open friable silt loam with small fragments of partly weathered yellow, green, purple, red, and gray shale.
- C. 6 to 18 inches, a mixture of brownish-gray silt loam or silty clay loam soil material and green, yellow, red, purple, and gray shale, the proportion of shale being much larger than in the layer above and apparently less weathered; the layer rests directly on fissile acid shale bedrock that is variegated in color in most places, including yellow, red, purple, green, gray, and in some places black bituminous shale.

Much of the soil is cleared, and the upper layers are missing because of loss through accelerated erosion.

LEHEW SERIES

The soils of the LeheW series were formed under a mixed forest of pine and hardwood from residuum weathered from purple, red, and green interbedded sandstone and shale. They have dominantly steep and very steep slopes and were formed under a climate essentially the same as that of other Lithosols of the area.

The rock underlying these soils is resistant to weathering, and soil material forms slowly. Because of the steep slopes this material is removed by geologic erosion almost as rapidly as formed, and there is no accumulation of material on which a mature zonal soil can develop. As mapped in the Norris area, these soils are true Lithosols. The chief difference between them and the Muskingum soils is in the color of the underlying rock, although in general the LeheW soils are on stronger slopes and have even less profile development.

The following is a profile description of LeheW fine sandy loam:

- A₁. 0 to 1 inch, grayish-brown friable fine sandy loam, purplish in places; contains some small fragments of purple, red, and gray shale and is matted with fine tree rootlets.
- A₂. 1 to 8 inches, purplish-brown to purplish-gray fine sandy loam with small fragments of purple, red, and yellow partly weathered shale and fine-grained sandstone.
- C. 8 to 24 inches, a mixture of purple sandy soil material and fragments of red, purple, yellow, and green shale and fine-grained sandstone; layer rests directly on consolidated bedrock, which consists of purple, red, and green shale interbedded with fine-grained sandstone of the same color; locally thin beds of limestone are in the underlying rock.

In many places where the soil is cleared, the upper layers are mixed and part of them may be missing in some places because of loss through accelerated erosion.

MUSKINGUM SERIES

The soils of the Muskingum series were developed from materials weathered from acid sandstone containing some layers of acid shale. Development was chiefly under hardwood forest, although locally there may have been some pine. The soils are on the steep and hilly slopes of the mountains of the area. In general the climate is similar to that under which the zonal soils developed, although it is possible that higher elevations have caused temperatures slightly lower and rainfall slightly higher than in other parts of the area.

The slow weathering of the sandstone underlying the Muskingum soils retards the formation of the parent material, which is removed by geologic erosion almost as rapidly as formed. Consequently, most of the Muskingum soils in the Norris area have a very weakly developed shallow profile. Because of their shallowness and weak development, they are classified as Lithosols, although they are probably more correctly classified as Lithosolic Yellow Podzolic soils in many places.

Following is a profile description of Muskingum stony fine sandy loam:

- A₁. 0 to 1½ inches, dark-gray loose fine sandy loam stained with organic matter.
- A₂. 1½ to 8 inches, brownish-gray to grayish-yellow loose fine sandy loam having no definite structure and consisting of a loose incoherent mass when disrupted; material contains angular sandstone fragments, is low in organic matter, and is heavily matted with tree rootlets.
- B₂. 8 to 16 inches, brownish-yellow sandy clay loam or sandy loam having a weakly developed nut structure that crushes easily into a soft friable mass when disrupted; contains a large quantity of angular sandstone fragments; in many places this layer is very indistinctly developed or entirely missing.
- C. 16 to 28 inches, fragments of partly weathered fine-grained sandstone or conglomerate in a matrix of brownish-yellow fine sandy clay; no definite structural development; mottled with gray, red, and brown.
- D. 28 inches +, consolidated bedrock, massive fine-grained acid sandstone or conglomerate with thin shale layers.

HECTOR SERIES

The soil of the Hector series is developed from materials weathered from acid sandstone and chiefly under hardwood forest. In general the climate is similar to that under which the zonal soils developed. The underlying sandstone weathers slowly, and because the soil is on steep slopes, the weathered material is removed by geologic erosion almost as rapidly as formed. In most places the Hector soil has a thin weakly developed profile and is classified as a Lithosol, but the soil mapped in the Norris area includes some areas that have shallow Red Podzolic profiles.

Following is a profile description of the only soil of the Hector series mapped in the area, Hector stony fine sandy loam, steep phase:

- A₁. 0 to 2 inches, dark grayish-brown loose fine sandy loam stained with organic matter.
- A₂. 2 to 12 inches, grayish-brown to light-brown very friable fine sandy loam; has no definite structure and forms a loose incoherent mass when disrupted; contains angular sandstone fragments and is matted with tree rootlets.
- B₂. 12 to 18 inches, yellowish-red to reddish-brown friable fine sandy clay loam having a weakly developed nut structure and containing a large quantity of angular sandstone fragments; this layer is entirely missing in many places.

- C. 18 to 30 inches, red friable fine sandy clay loam, spotted with yellow and gray and mixed with partly weathered sandstone.
- D. 30 inches +, consolidated bedrock, massive fine-grained acid sandstone.

ALLUVIAL SOILS

Alluvial soils are an azonal group of soils developed from transported and relatively recently deposited material (alluvium) characterized by a weak modification (or none) of the material by soil-forming processes (12). In the Norris area these soils are on first bottoms along streams, in depressions, and on foot slopes. They have nearly level, gently sloping, and depressional relief and good to very slow internal drainage. They commonly lack a soil profile in which the horizons are genetically related. The properties of the soil are closely related to the alluvial deposit.

Alluvial soils derived from similar parent materials may differ in drainage conditions, and some differences in properties may therefore exist. Such soils have been differentiated mainly on the basis of properties associated with good, imperfect, or poor drainage.

ROANE SERIES

The soil of the Roane series (Roane silt loam) formed under hardwood forest on narrow bottoms along small streams in the cherty ridges. Slopes are nearly level. This soil is closely associated with the Clarksville and Fullerton soils from which its parent materials were washed. It is young and is generally higher in humus, phosphorus, and bases than are the associated upland soils. Although varying in reaction according to source of parent materials, the soil is consistently less acid than the associated soils of the uplands.

The following is a profile description of Roane silt loam:

1. Brown to grayish-brown friable silt loam, in the virgin condition stained dark with organic matter in the upper 2 or 3 inches and heavily matted with rootlets; generally contains a small or moderate quantity of fine chert fragments; layer is 10 to 24 inches thick.
2. A firm compacted or cemented layer of small chert fragments and brownish clayey soil material; contains some gray and yellow mottlings; forms a loose mass of chert fragments and soil material when disrupted; layer is a few inches to nearly 2 feet thick and the factors responsible for its formation are not known.
3. Silty stream alluvium with much chert.

LINDSIDE SERIES

The Lindsides series is represented in this area by one type, Lindsides silt loam. It is an imperfectly drained soil on first bottoms derived from young stream alluvium washed chiefly from limestone materials. The soil has nearly level relief. It was formed under hardwood forests, is young, and does not have a developed profile. In general it is higher in bases, phosphorus, nitrogen, and humus than are the associated zonal soils of the uplands and terrace lands.

The 18-inch surface layer of Lindsides silt loam is typically a mellow friable grayish-brown or brown heavy silt loam with a few fragments of chert or gravel. The upper inch or two of the virgin profile is stained dark with organic matter. The surface layer is underlain by a gray silty clay loam, mottled with ocher and dark gray, and contains some soft black and brown concretions. The mottlings and concretions follow old root channels. The underlying alluvium

is typically mottled clay containing some chert or gravel beds. The gray layer of this soil is saturated with water through much of the year. In some respects it is glei-like, and the Lindsides soil might be defined as an Alluvial soil with a glei horizon.

POPE AND PHILO SERIES

Soils of the Pope and Philo series are on nearly level first bottoms and consist of alluvium washed chiefly from acid sandstone and shale. They are closely associated with the Muskingum, Montevallo, and Lelew soils. Pope and Philo soils were developed under hardwood forest; the association of forest trees varies somewhat among the soils of the two series because of drainage differences. The soils are young and do not have distinct genetic profiles. They differ from the Lindsides in being derived to a greater extent from material washed from acid rock rather than from limestone. They are higher in bases, phosphorus, and nitrogen than are the associated soils in the uplands.

The Pope soil is well drained. The surface 10 to 12 inches is grayish-brown fine sandy loam, and in the virgin profile the upper 2 or 3 inches are stained with organic matter. This layer is underlain by light-brown to yellow fine sandy loam. Below a depth of 3 feet this material may contain some gray mottlings. The underlying alluvium is somewhat stratified and may contain beds of coarse sand, gravel, and some silt. In most places this alluvium is many feet thick and is underlain by sandstone bedrock.

The Philo soil is imperfectly drained. The surface 10 to 15 inches is typically brownish-gray friable fine sandy loam. In many places this layer is stony or gravelly. It is underlain by gray fine sandy loam heavily mottled with yellow and brown. The underlying alluvium is very similar to that of Pope soils. The gray subsoil layer is saturated with moisture in all but the driest seasons of the year. In some respects it is glei-like, and the Philo soil might be designated as an Alluvial soil with a glei horizon.

EMORY SERIES

The soil of the Emory series (Emory silt loam, undulating phase) is along foot slopes and benches at the base of high hills, chiefly along small intermittent streams. It consists of local alluvium and colluvium washed from Bolton, Claiborne, Talbott, and Dewey soils, with which it is closely associated geographically. Relief is nearly level to gently sloping. The soil developed under hardwood forest and was subject to a climate similar to that under which the associated zonal soils were formed, but its materials are so recently deposited that soil-forming processes have not had time to act, and no genetic profile has developed. The Emory soil is young and is included with the Alluvial soils.

Following is a profile description of Emory silt loam, undulating phase:

1. 0 to 12 inches, very friable mellow dark-brown heavy silt loam with a fine crumb structure; in many places this is a very recent accumulation of material washed from the adjoining upland slopes; in the virgin soil the upper 2 or 3 inches are darkened with humus.
2. 12 to 30 inches, dark yellowish-brown to light-brown mellow and friable heavy silt loam that has a crumb or fine granular structure; small dark-brown concretions similar to those in the B horizons of the Bolton soils are numerous in the lower part.

3. 30 to 48 inches, brown, yellowish-brown, or reddish-brown moderately friable heavy silt loam; contains some small chert fragments and numerous concretions similar to those in the layer above; colluvial and alluvial materials similar to those of this layer extend to depths of many feet and are generally underlain by dolomites.

GREENDALE SERIES

Soils of the Greendale series are on foot slopes at the base of hills along intermittent streams and in the bottoms of large lime sinks. Their parent materials consist of local alluvium and colluvium washed from the Clarksville and Fullerton soils on the adjoining upland slopes. They have nearly level to sloping relief. The soils developed under a hardwood forest, and the climate was essentially the same as that under which the associated zonal soils formed. The materials of the Greendale soils were recently deposited, and in most places there are frequent additions of material from adjoining upland slopes. As a result the soils are young and generally have little profile development. Some of the soils included in the Greendale series have rather distinct though young genetic profiles, and they would be classified as Yellow Podzolic soils. In the Norris area, however, nearly all of these soils are so young and have such indistinct or weakly developed profiles that they are more correctly classified as Alluvial soils.

Following is a profile description of Greendale silt loam, undulating phase:

1. 0 to 10 inches, gray to light grayish-brown loose open friable silt loam; in the virgin profile the upper 1 or 2 inches is darkened with organic matter; layer contains small angular chert fragments.
2. 10 to 24 inches, light brownish-yellow to yellow moderately friable silt loam to light silty clay loam; contains some minglings of gray from the overlying layer and breaks into small soft subangular aggregates; contains a considerable quantity of angular chert fragments.
3. 24 to 40 inches, strongly acid yellow light silty clay loam mottled with gray and brown in places; somewhat firm in place but crumbles to a loose incoherent mass when disrupted; material contains 50 percent or more of angular chert fragments by volume; underlying colluvial deposits are a mixture of yellow to light-brown soil material and angular chert fragments and extend to depths of many feet; generally underlain by cherty dolomite bedrock.

GREENDALE SERIES

The soil of the Ooltewah series (Ooltewah silt loam) is chiefly in shallow depressions in uplands underlain by limestone. The parent materials consist of local alluvium and colluvium washed chiefly from Talbott and Dewey soils, although Fullerton and Clarksville soils contribute some materials in places. The Ooltewah soil developed under a hardwood forest, and the climate was essentially the same as that under which the associated zonal soils were formed. It receives frequent increments of soil material from the adjoining upland slopes, and as a result, material accumulates more rapidly than the soil-forming process can act. The soil is therefore young and has no genetic profile. It is imperfectly drained and has a gray mottled layer, which is glei-like in some of its properties. The soil can be designated as an Alluvial soil with a glei horizon.

Following is a profile description of Ooltewah silt loam:

1. 0 to 15 inches, light-brown to grayish-brown moderately friable heavy silt loam with a crumb or fine granular structure and faint gray mottlings in the lower part; in a virgin profile the upper few inches are darkened with humus.

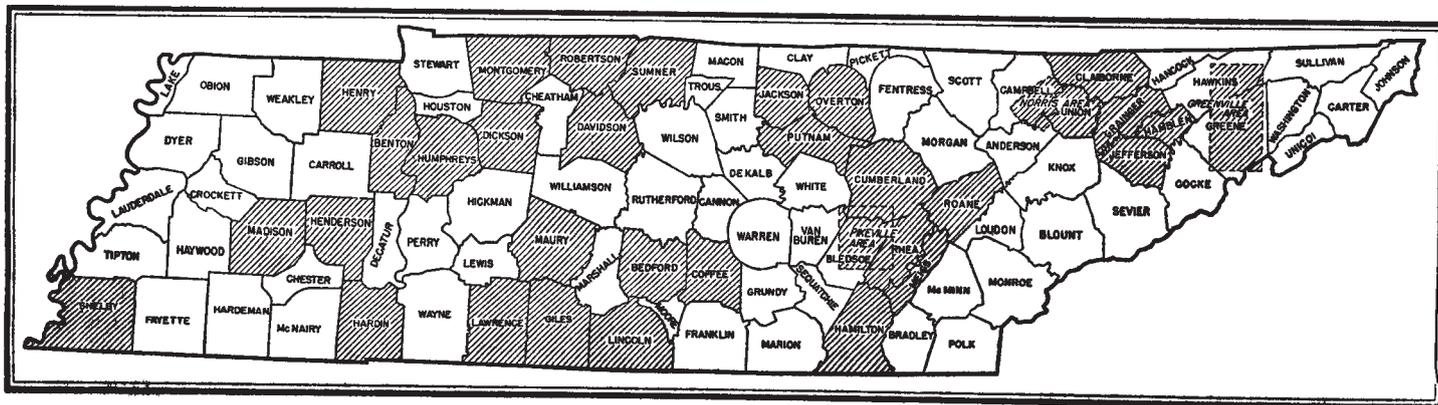
2. 15 to 40 inches, gray silt loam to silty clay loam mottled with brown and yellow; contains many soft red and brown concretions; is somewhat sticky and plastic when wet and moderately friable when moist, crumbling to a soft granular mass.

The underlying colluvial material is dominantly gray silty clay loam mottled with yellow and brown. It contains some chert fragments in places. Limestone bedrock is at depths of several feet.

LITERATURE CITED

- (1) AUTEN, J. T.
1933. POROSITY AND WATER CONTROL OF FOREST SOILS. Jour. Agr. Research 46: 997-1014, illus.
- (2) BORN, K. E.
1936. SUMMARY OF THE MINERAL RESOURCES OF TENNESSEE. Tenn. Dept. Ed., Div. of Geol., Resources of Tenn. (2d ser.). 102 pp., illus.
- (3) BORST, H. L., MCCALL, A. G., and BELL, F. G.
1945. INVESTIGATIONS IN EROSION CONTROL AND RECLAMATION OF ERODED LAND AT THE NORTHWEST APPALACHIAN CONSERVATION EXPERIMENT STATION, ZANESVILLE, OHIO, 1934-42. U. S. Dept. of Agr. Tech. Bul. 888, 95 pp., illus.
- (4) CARTWRIGHT, P.
1857. AUTOBIOGRAPHY OF PETER CARTWRIGHT, THE BACKWOODS PREACHER. Edited by W. P. Strickland. 525 pp. New York.
- (5) CLARKE, F. W.
1924. THE DATA OF GEOCHEMISTRY. U. S. Geol. Survey Bul. 770, Ed. 5, 841 pp.
- (6) COPLEY, T. L., FORREST, L. A., MCCALL, A. G., and BELL, F. G.
1944. INVESTIGATIONS IN EROSION CONTROL AND RECLAMATION OF ERODED LAND AT THE CENTRAL PIEDMONT CONSERVATION EXPERIMENT STATION, STATESVILLE, N. C., 1930-40. U. S. Dept. Agr. Tech. Bul. 873, 66 pp., illus.
- (7) DENUYL, D., and DAY, R. K.
1934. WOODLAND CARRYING CAPACITIES AND GRAZING INJURY STUDIES. Ind. Agr. Exp. Sta. Bul. 391, 12 pp., illus.
- (8) FENNEMAN, N. M.
1938. PHYSIOGRAPHY OF EASTERN UNITED STATES. 714 pp., illus. New York and London.
- (9) HALL, R. C.
1910. PRELIMINARY STUDY OF FOREST CONDITIONS IN TENNESSEE. Tenn. Geol. Sur. Bul. 10 A, 56 pp., illus.
- (10) KELLOGG, C. E.
1937. SOIL SURVEY MANUAL. U. S. Dept. Agr. Misc. Pub. 274, 136 pp., illus.
- (11) KILLEBREW, J. B., assisted by SAFFORD, J. M., CHARLTON, C. W., and BENTLEY, H. L.
1874. INTRODUCTION TO THE RESOURCES OF TENNESSEE. Tenn. Bur. Agr. Rpts. 1-2, 1193 pp., illus.
- (12) MARBUT, C. F.
1935. SOILS OF THE UNITED STATES. U. S. Dept. Agr. Atlas of American Agriculture, pt. 3, 98 pp., illus.
- (13) MINKLER, L. S.
1941. FOREST PLANTATION SUCCESS AND SOIL-SITE CHARACTERISTICS ON OLD FIELDS IN THE GREAT APPALACHIAN VALLEY. Soil Science Society of America Proceedings, 1941, 6: 396-398.
- (14) ———
1944. EARLY RESULTS FROM A REFORESTATION "PILOT PLANT." Jour. Forestry 42: 586-590, illus.
- (15) MOON, J. W., HIGBEE, H. W., ROBERTS, W., and others.
1941. SOIL SURVEY OF JEFFERSON COUNTY, TENNESSEE. U. S. Dept. Agr. Bur. Plant Indus., Soil Survey Rpt., ser. 1935, No. 20, 104 pp., illus.
- (16) RAMSEY, J. G. M.
1853. THE ANNALS OF TENNESSEE TO THE END OF THE EIGHTEENTH CENTURY . . . 832 pp., illus. Kingsport, Tenn. (Reprint, 1926.)

- (17) STERRETT, W. D.
1917. MARKETING WOODLOT PRODUCTS IN TENNESSEE. Tenn. Geol. Survey.
Resources of Tennessee 7: [109]-195, illus.
- (18) UNITED STATES DEPARTMENT OF AGRICULTURE
1938. SOILS AND MEN. U. S. Dept. Agr. Yearbook 1938, 1232 pp., illus.
- (19) UNITED STATES GEOLOGICAL SURVEY.
1901. GEOLOGIC ATLAS OF UNITED STATES, MAYNARDVILLE, FOLIO, TENNESSEE.
Folio 75, [13] pp., illus.
- (20) _____
1896. GEOLOGIC ATLAS OF UNITED STATES, MORRISTOWN, FOLIO, TENNESSEE.
Folio 27, [13] pp., illus.
- (21) WILLIAMS, S. C.
1924. HISTORY OF THE LOST STATE OF FRANKLIN. 378 pp. New York.
(Revised, 1933.)



Areas surveyed in Tennessee shown by shading.

NRCS Accessibility Statement

This document is not accessible by screen-reader software. The Natural Resources Conservation Service (NRCS) is committed to making its information accessible to all of its customers and employees. If you are experiencing accessibility issues and need assistance, please contact our Helpdesk by phone at 1-800-457-3642 or by e-mail at ServiceDesk-FTC@ftc.usda.gov. For assistance with publications that include maps, graphs, or similar forms of information, you may also wish to contact our State or local office. You can locate the correct office and phone number at <http://offices.sc.egov.usda.gov/locator/app>.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotope, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.